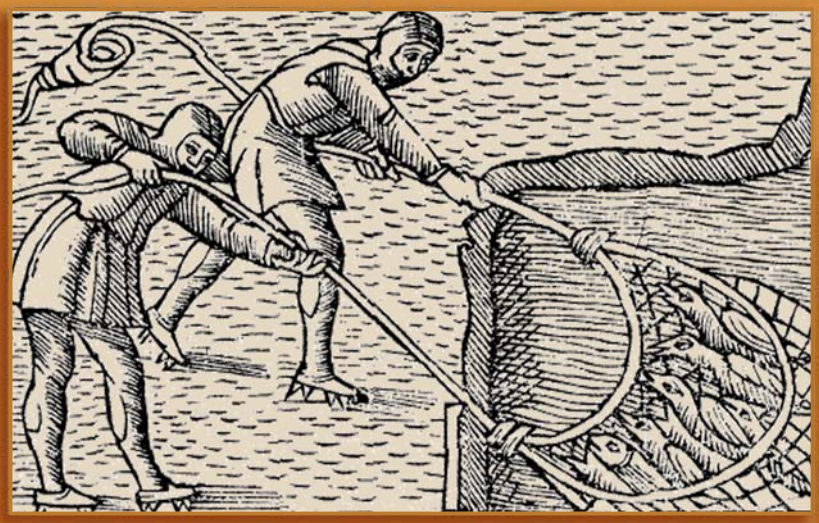
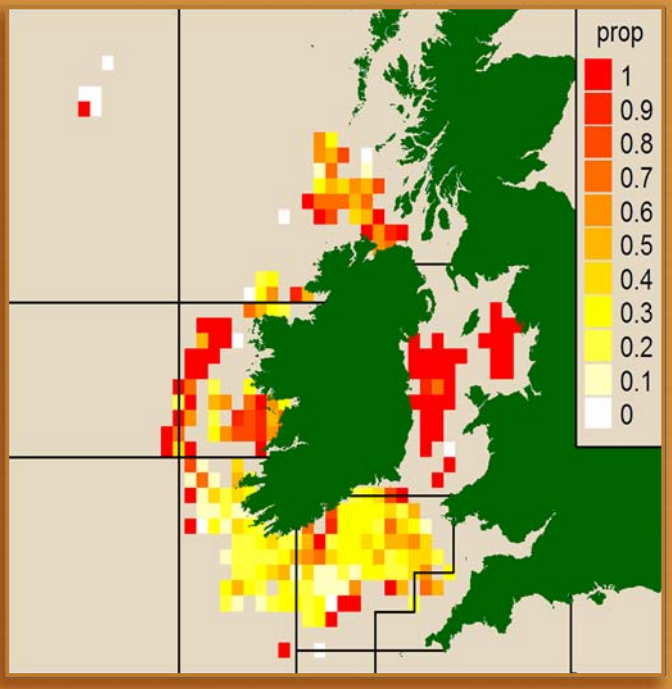
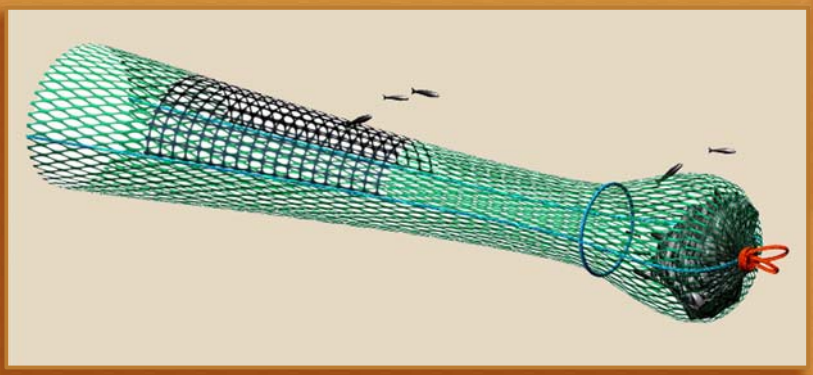
Atlas of Demersal Discarding

Scientific Observations and Potential Solutions







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Atlas of Demersal Discarding

Scientific Observations and Potential Solutions

"An Atlas of Discarding Profiles by the Irish Demersal Fleet with a Toolbox of Mitigation Measures"

September 2011

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The images on the cover :

- Medieval Scandinavian ice fishing technique (published 1555).
- Map show the data observed from discard trips carried out between 1995-2009.
- Square mesh panel inserted into a conventional diamond mesh cod-end. (Crown Copyright, courtesy of Marine Scotland).

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"We must put an end to the nightmare of discards.....we cannot go on like this....we need a new policy"

Maria Damanaki
European Commissioner for Maritime Affairs and Fisheries
February 2011

The purpose of this Atlas is to present the scientific observations on discarding by the Irish Demersal fleet. These scientific observations will inform debate on how to significantly reduce discards in Ireland's demersal fisheries. However, discarding occurs in all EU fleets. It is critical that the EU develop a European Discard Atlas in order to understand the extent of the problem and therefore introduce appropriate mitigation measures.

SUMMARY

Societal demands to reduce discarding and other impacts associated with fishing are growing. Pressure is increasing on policy makers, fishermen and scientists to 'do something about the discard problem'. The EC proposal on the reform of the Common Fisheries Policy states that discarding will be phased out. Fishermen will be obliged to land all the commercial species that they catch In order to address the discard issue, fisheries should first be evaluated (audited) to identify the specific discard problems and to reference these against the available mitigation tools i.e. measures to reduce discards. This Atlas represents a first attempt at auditing Irish fisheries and proposes some options to mitigate discards.

It is important to note that Irish fleets exploit stocks that are also fished by other nations. In many cases, Ireland may only have a minority of the Total Allowable Catch (TAC) and account for only part of the overall discards**. Therefore, to understand the significance of discarding associated with Irish vessels, it is important to consider the contribution that they make relative to the international catch. The contribution of Irish fisheries to the overall fishing pressure varies considerably across areas and species, from fractions of a percent, (e.g. West of Scotland cod) to being a significant contributor (e.g. Irish Sea haddock). It is therefore critical to develop a European Discard Atlas if we are to quantify the key international fisheries and tackle the north east Atlantic discard issue.**

Discarding is driven by economic and/or legislative reasons. Lack of marketing opportunities, minimum landing size and restrictive quota limits can all result in discarding. The practise represents an under-utilisation of marine resources and may significantly affect stock productivity.

Internationally, demersal (bottom) trawl fisheries are regarded as having the largest discard 'problem'. The FAO estimates that demersal trawling accounts for over 50% of global discards. In a review of global discarding, the FAO noted the northeast Atlantic has the highest discard level in the world, estimated at 1.3 million tonnes, the majority attributed to EU fisheries.

The majority of EC fisheries are controlled and monitored based on the fish *landed* rather than the fish *caught*. Consequently, the most cost effective way to deal with unwanted by-catch by individual vessel operators has been to discard. Currently there is no financial benefit in avoiding discarding as there is no individual cost to fishers associated with discarding.

Since the introduction of the EU Data Collection Regulation (2002 - 2008) and the subsequent Data Collection Framework (2009 – present), monitoring the catches on board fishing vessels is undertaken routinely all around the European coast. While this data is principally collected for fishery and stock assessment purposes, the broad observer coverage and the relatively long time series, allows the data to be used to understand the dynamics of discarding. This can be used to aid the development of mitigation tools tailored to specific fleets or areas – rather than just simply quantifying the problem.

The basis of the information presented in this Atlas is from the Marine Institute's 'at sea' sampling programme which has been in place since 1993. While the Irish sampling programme is broad like all other EU at sea programmes, the sampling coverage relative to the total fleet effort is small, typically less than 1%. The low sampling levels and the inherent variation in discarding levels between trips, even with the same vessel and gear, makes the data very variable.

This Atlas provides an overview of Irish discarding practices around Ireland by species and identifies the scale of discarding associated with the main demersal fisheries. The discard profiles of the 'top 10' commercial demersal species by landed weight are presented as well as the 'top 10' non-commercial fish species by discarded weight. Between 2003-2009, the 'top 10' Irish commercial species produced an average catch of 36,600 tonnes per year with associated discards of at least 14,000 tonnes per year in Irish demersal fisheries, giving an average discard rate of 38% per annum. Over the same period, the Irish fleet discarded at least 7,200 tonnes per year of the 'top 10' non commercial fish species. It should also be noted that discard levels and rates have declined between 2003 and 2009 with the adoption of new technical

measures and reductions in fishing effort associated with the long term management plan for cod and the national decommissioning schemes (2006 & 2008).

Discard rates of haddock, whiting, plaice, megrim and hake is high in a number of fisheries. Discarding of these species is largely due to incompatibility between the size of fish desired by the market and the size of fish caught in the gear. This implies that technical changes to the size selectivity of the gear, such as increasing the mesh size or introducing square mesh panels, would reduce the discard level. However, in mixed fisheries these technical changes can also result in losses of other marketable species. Managing to reduce discards in mixed species fisheries is complex involving many trade offs.

The atlas presents some technical solutions to reduce discarding in some key Irish demersal fisheries. There are a wide range of **technical solutions** available to help reduce the capture of undersize or unwanted species. These technical solutions are broadly categorised into modifications that improve the size selectivity of target and by-catch species, therefore reducing the capture of small individuals and those modifications that are designed to exclude specific species. Five technical measures appropriate for trawl and seines are shown together with a brief description of its operation and potential suitability for Irish fisheries.

Analysis of the haddock and whiting discard data clearly shows that the level of discards in the Celtic Sea is high. This is incompatible with the policy objective of achieving Maximum Sustainable Yield (MSY) by 2015. The impact on whiting and haddock catches in terms of reduction in discards and loss of marketable fish are presented for two possible scenarios (introducing a 110mm square mesh panel or increasing the cod-end mesh size to 100mm and together with a 110mm square mesh panel) In both scenarios, the discarding of both haddock and whiting are predicted to fall considerably (>60%). However, there are also substantial reductions in the catch of marketable whiting retained but there is minimal impact on haddock landings.

The impact of the introduction of a sorting grid on the landings and discards is also presented. Three Irish vessels are currently using this device in the Irish Sea exempting them from effort restrictions linked the cod management plan. The data shows the desired reductions in cod catches are being achieved and that selection grids also significantly reduce the by-catch and discards of many other species. The overall discard reductions for the remaining species being well in excess of 70%.

Management policies that promote and incentivise the use of more selective gears and shift away from regulating fisheries based on what is landed towards one that is based on what is caught are clearly needed in European fisheries. It should be noted also that in Ireland's response to the Commission Green paper on the reform of the Common Fisheries Policy it states "*Ireland would stress that the gradual elimination of discards is dependent on a strong industry, science, gear technology partnership particularly when it comes to identifying problem fisheries and implementing effective remedial actions. The Regional Advisory Councils (RAC's) are a key forum for this partnership*."

The Marine Institute and BIM would like to thank the skippers and crews for their co-operation and help in the collection of at sea discard data and also during various gear trials. The at-sea sampling programmes are the most reliable method of obtaining data on the amount and type of discards while gear trials provide detailed selectivity information on measures that can be tailored to Irish fisheries. Discard data are an essential input to stock assessment and the provision of scientific advice on fishing opportunities for the Irish fleet. Sampling at sea programmes also offer a unique opportunity for a dialogue between fishermen and fisheries scientists.

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1 INTRODUCTION

Purpose of the Atlas

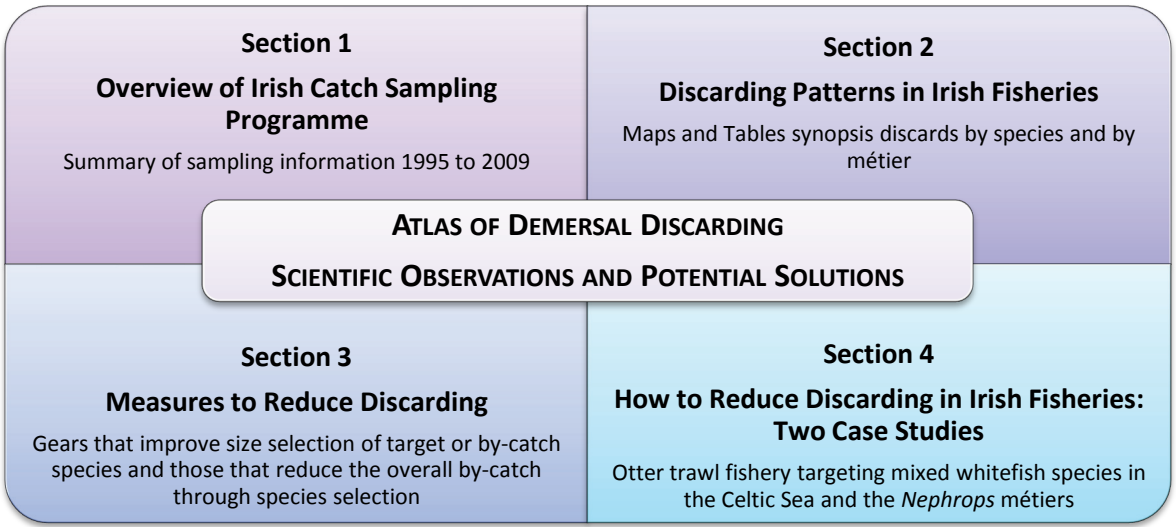
Societal demands to reduce discarding and other impacts associated with fishing are growing. Pressure is increasing on policy makers, fishermen and scientists to 'do something about the discard problem'. Discarding is high on the agenda in the upcoming review of the Common Fisheries Policy (CFP) and within the Commission, Member States and the fishing industry there is considerable discussion on appropriate management measures to mitigate discarding. In order to address the issue, fisheries should first be evaluated (audited) to identify the specific discard problems and to reference these against the available mitigation tools i.e. measures to reduce discards. This Atlas represents a first attempt at auditing Irish fisheries and proposes some options to mitigate discards. It should be emphasised that discarding occurs in all international fleets operating in the waters around Ireland and that mitigation measures must be applied to all these fleets if we are to implement a successful discard reduction policy.

The purpose of this Atlas is to present the scientific observations on discarding by the Irish Demersal fleet in a non technical way. These scientific observations will inform debate on how to significantly reduce discards in Ireland's demersal fisheries and are a key step on the road to sustainable fisheries. The information is presented in a highly visual format and the language used is as non technical as possible. The target audience is scientists, managers, policy movers, industry, Non Government Organisations (NGO's) and the general public.

In Ireland's response to the Commission Green paper on the reform of the Common Fisheries Policy it states "*Ireland recognises that discarding is a major issue in European fisheries that must be addressed in a reformed CFP as a high priority*". Furthermore, the response states that there is need to carry out a comprehensive analysis of the large amount of discard data that has been collected through the Data Collection Framework and produce an **Atlas of discarding in all EU fisheries**. This will identify the location and extent of the problem. This is a key step to develop remedial actions, that can be selected from a toolbox of measures that are fishery specific. The objective of this document is to present the scientific facts in relation to discarding for the Irish demersal fisheries. This Atlas will hopefully serve as a template in producing a European Discard Atlas.

Format of the Atlas

The atlas is divided into four main sections – Overview of Irish catch sampling, Irish Discarding Patterns by Species, Technical Methods to Reduce Discarding, and Reducing Discards in Irish Fisheries: Two Case Studies.



The appendices in the Atlas provide a detailed description of Irish fisheries broken down by fleet segment or métier (appendix I), a map of the fishing grounds in the waters around Ireland (appendix II), while throughout the text there are a number of key references to relevant scientific publications which give a more detailed analysis of the points raised in the Atlas. These references are listed in appendix IV and cited in the text in square brackets (e.g. [3]). Reference is made to the International Council for the Exploration of the Seas (ICES) areas and divisions throughout Key points are highlighted in yellow boxes, while the purples boxes contain definitions of terms used within the text.

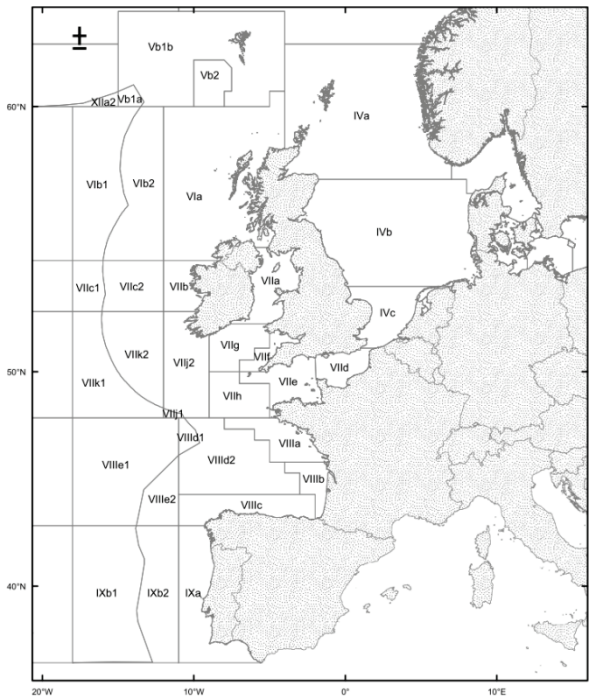


Figure 1.1 International Council for the Exploration of the Seas (ICES) showing the regional sub-divisions used throughout the atlas.

Discards and By-Catch

Before examining Irish discards in detail, it is important to clarify some terminology, explain why discarding occurs and show why it is important to monitor it.

The terms "by-catch' and "discard" have been a source of confusion in the scientific literature and can differ in meaning between countries and management jurisdictions. It is important to distinguish between these terms. Both terms have become synonymous with negative aspects of commercial fishing and considered to be interchangeable by many. This is not the case. In the context of the work presented here, discard is considered to be the dumping of the un-wanted portion of the catch whereas by-catch is the part of the catch that is captured incidentally to the target species [1] and as such may have some economic value.

Discards as a source of total mortality

Discards are an unavoidable consequence of fishing activity, particularly in mixed fisheries, and can be a major source of mortality for some stocks. Figure 1.2 illustrates the relationship between catch, landing, discard and the total fishing related mortality. It also illustrates some of the main reasons for discarding in practices. In practice, the total mortality caused by landings, discards and other fishing related accounted mortality will vary considerably between fisheries.

In single species fisheries, where the mesh selection and minimum landings size is well matched, then discarding and discard related mortality should in theory be minimal. However, in multi-species fisheries operating in areas of high biodiversity with a complex legislative structure of input (i.e. fishing effort) and output (i.e. catch) controls, discarding can be highly problematic.

Landings: *Fish or shellfish that are brought ashore.*

Discard: *Are the portion of a catch of fish which is not retained on board during commercial fishing operations and is returned, often dead or dying, to the sea.*

Catch: *The total number (or weight) of fish caught by fishing operations. Catch = Landings + Discards.*

By-catch: *The part of the catch that is captured incidentally to the target species which may have some economic value.*

Discard Rate: *The percentage of the total catch by species discarded in weight or number. If a vessel catches 10 tonnes, discards 3 tonnes and lands 7 tonnes, the discard rate is 30% by weight.*

Discard Level: *The amount in weight or number discarded. If a vessel catches 1000 tonnes, discards 300 tonnes and lands 700 tonnes, the discard rate is the same as above, but the contribution to overall discards is of that species is 100 times higher (i.e. 300 tonnes as opposed to 3 tonnes).*

Fishing Effort: *The fishing effort is a measure of the amount of fishing. Often when measuring fishing effort catching power is also taken into account e.g. KwDays for trawlers or Net length x soak time for gill nets.*

Societal demands to reduce discarding and other impacts associated with trawling are growing. Pressure is increasing on policy makers, fishermen and scientists to 'do something' about the 'discard problem'. In order to address the issue, fisheries should first be evaluated (audited) to identify the specific discard problems and to reference these against the available "mitigation tools" (i.e. measures to reduce discards). This Atlas represents a first attempt at auditing Irish fisheries and proposes some options to mitigate discards.

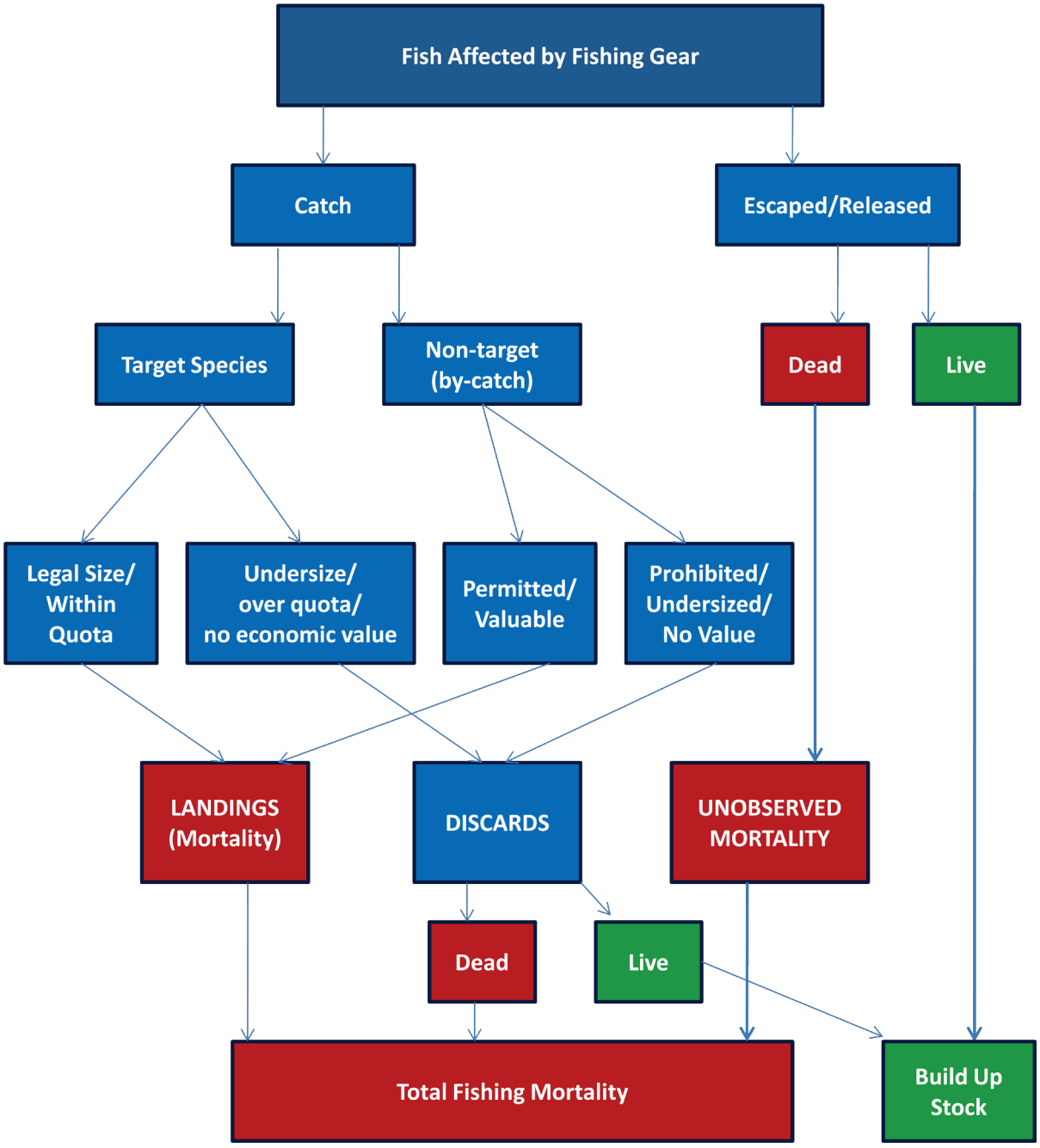


Figure 1.2 **Potential fate of animals encountering the fishing gear and its relation to by-catch, discard, landings and other components of fishing mortality. [2]**

Fishing Mortality: *Is the removal and death of fish from the stock due to fishing activities using any fishing gear. Where discards are accurately known total fishing mortality can be partitioned into that caused by landings and discards.*

High Grading: *Is the practice of discarding fish above the minimum landing size for economic reasons i.e. not marketable or to maximise the monetary return from limited quota.*

Unaccounted Fishing Mortality: *Any deaths that are not quantified, for example fish lost during retrieval of the gear and not taken on board, illegal landings, fish deaths due to contact with fishing gear but not caught or fish caught in lost or abandoned fishing gear.*

What causes discarding?

A fishing vessel may discard part of their catch for a variety of reasons, but the main reasons are linked to economic/market considerations or to comply with regulations. Lack of marketing opportunities, quality considerations or large price differentials between or within species (high grading) can all induce discarding, the main drivers and their contribution varies considerably across fisheries and target species. [3,4,5]

The management framework and stock status strongly influences discard levels. Fisheries that are managed extensively by landings controls and catch composition regulations are often characterized by high discard rates. It is important to note that in Europe although annual fishing opportunities are derived from Total Allowable Catch or TACs in fact it is total landings not catch that are controlled. Discarding in multi-species fisheries is particularly problematic. When the quota for one species is exhausted, but opportunities remain for others, fishers may continue to fish for the latter while discarding the former.

Similarly, regulations setting limits to percentage catch composition on board a vessel may compel fishers to discard excess catches of specific species. Fishers are aware that 'regulatory' discarding of marketable dead fish serves no conservation purpose. This undermines their faith in the management system and can lead to non-compliance and illegal landings.

Quota-induced discarding may be reduced by restricting effort or by setting lower quota for all species caught in the mixed fishery to protect the most vulnerable species. However, this may result in under utilisation of the target resource.

Inappropriate selectivity characteristics of the gear (specifically the legal minimum mesh size – MMS) and the legal minimum landing size (MLS) is also a major problem in multi species fisheries. For example many beam trawl fisheries target sole with 80mm mesh which is compatible with the MLS for sole but also results in high catches of small plaice for which there is no market. Discard rates for plaice are very high as a consequence.

Fisheries that target overexploited species tend to be characterized by relatively high discard rates. Not only is the natural balance shifted towards an excess of relatively small individuals, but fishers may also increasingly target smaller fish to maximize catches of fish above MLS. Increasing the mesh size under these circumstances could result in a high loss of landings, and could result in an incentive to reduce gear selectivity to retain as many fish above MLS as possible [6]. This problem is even more acute in multi-species fisheries, where each of the target species has its specific MLS that may not be tuned to the size selectivity of the prescribed mesh size.

A fishing vessel may discard part of their catch for a variety of reasons, but the main reasons are linked to economic/market considerations or to comply with regulations. It is the combined interplay of fishery regulations, economic considerations and the catch composition that determine the level and pattern of discarding associated with a particular métier.

Discarding – a global perspective

Discarding is recognised as a significant problem in fisheries worldwide. Trawl fisheries in waters of the European Union (EU) are generally associated with medium to high levels of discards, particularly in mixed species demersal fisheries. [4] In a review of world discarding, the FAO noted that the Northeast Atlantic (FAO area 27) has the second highest discard level in the world, estimated to be 1.3 million tonnes, the majority being attributed to EU fisheries. This problem is generally worst in multi-species fisheries where individual quota allocations and catch (landing) composition regulations are mismatched between fishing opportunities and availability.

[7] Published scientific work has shown that beam and otter trawling in ICES Sub-area VII discarded 71% and 64% of their catch by numbers, respectively and 42% and 36% by weight.

The FAO review [4] noted that the dominance of demersal trawl gear, high species diversity, and high discards by important shrimp, *Nephrops*, and flatfish fisheries contributed to a high aggregate discard rate. During the 1990s, it is estimated that between 500,000 and 888,000 tonnes of fish was being discarded annually in the North Sea [4] . More recently, discard *levels* in the North Sea have reduced, primarily due to significant reductions in fishing effort. However, discard *rates* have remained stable or in some cases increased, suggesting that selectivity has reduced [4].

Internationally it is recognised that managing discards is complex. Each fishery or management unit is likely to require a specific suite of measures to minimise discards [4]. Such measures should be formulated as an integral part of a fishery management plan. In overexploited fisheries, effort reduction is likely to be an essential approach to decreasing discards. Effort reduction may not be necessary if efforts to promote discard reduction devices or other technical measures take a central role. Economic measures can make an important contribution to discard reduction and management.

It should also be noted that while more selective fishing is advocated as a means of reducing discards. This is also likely to alter current ecosystem balance. Various scientific studies have shown that discards have become an important food source for populations of some seabird species and also for benthic scavengers. Discard reduction plans should be assessed in a wider ecosystem context.

To highlight the variation that individual countries make to overall discard levels, two examples are given below. The data come from the latest assessments carried out by ICES.

(i) Cod in the West of Scotland (ICES Sub-division VIa)

For VIa cod (Figure 1.3), discard and landings data are provided to the ICES Working Group on the Celtic Seas Eco-region (2010) by Ireland and Scotland, while for the other countries (France, Germany, Spain) only landings data are provided. While Scotland, Ireland and the others contribute 45%, 20% and 35% of the landings respectively, the contribution they make to the discards shows a very different picture. Discards associated with the Scottish and other fleets are 56% and 46% respectively, while Ireland contributes <0.1% of the total. In the example presented above, as the 'other' countries do not provide discard data, the level of discards associated are estimated based on the proportion of discards associated with the Scottish fleet. This application of discard rates is done to provide some estimate of total catch for stock assessment purposes, but it may not necessarily reflect the true picture for these countries. In order to obtain a more precise estimate, all countries need to provide discard information.

(ii) Haddock in the Irish Sea (ICES Sub-division VIIa)

The second example (Figure 1.4) is taken from haddock in the Irish Sea (ICES division VIIa). Here, the picture is somewhat different. The discard levels associated with the Northern Irish, UK and Irish fleets are broadly similar, with all discarding in excess of 30% of their respective catch.

Both these cases illustrate that discarding profiles between countries can vary considerably and in order to determine where the main source of discards are, it is necessary that an international picture of discarding levels is produced to identify where mitigation measures are required.

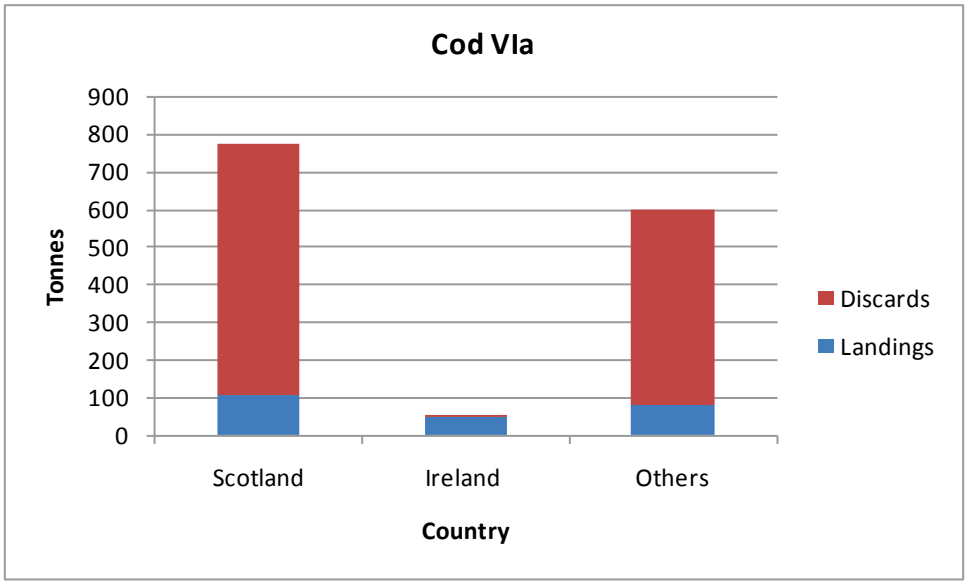


Figure 1.3 **International Cod Landings and Discards in ICES Division VIa in 2010.**

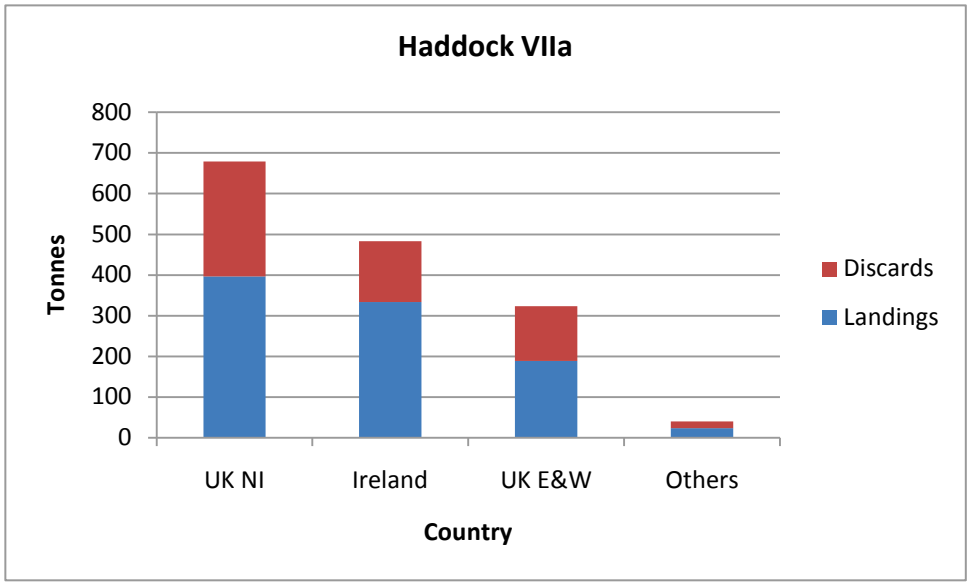


Figure 1.4 **International Haddock Landings and Discards in ICES Division VIIa in 2010.**

In a review of world discarding, the FAO noted that the Northeast Atlantic (FAO area 27) has the second highest discard level in the world, estimated to be 1.3 million tonnes, the majority being attributed to EU fisheries [4].

The causes and the management of discarding is complex and mitigation requires a range of tailored management approaches.

Discarding profiles between countries can vary considerably and in order to determine where the main source of discards are, it is necessary that an international picture of discarding levels is produced to identify where mitigation measures are required.

Discarding – an Irish Perspective

In Ireland, in common with most European fisheries, the majority of discarding is associated with the capture of fish that are either below the minimum landing size, fish for which there are no commercial value or where the quota has been exhausted.

It is important to put discards associated with Irish fleets into the international context of the fisheries in which they operate. Discarding contributes to the overall fishing mortality at the stock level. Therefore for benefits to be felt at a stock level, it is necessary that those fleets that make the highest contribution are the primary focus for discard reduction plans.

While a given fishery may have relatively high discard rates, if the catch or effort associated with the fleet is small in comparison to other fleets, then the benefit of reducing discards will be minimal. In order for one to gain a more informative view of the scale and impact of discarding at a stock level, it would be necessary to include all the internationally available data.

Figure 1.5 shows the relative Irish share of the international TACs for ICES divisions VI and VII (the waters around Ireland). This illustrates that the quota share to Ireland is around about 25% of the total allowable catch (landings). In order to understand the relative contribution Ireland makes in relation to other countries in terms of total catch (landings plus discards), a **discard Atlas of all EU fisheries would be a very positive and informative step to help tackle the issue.**

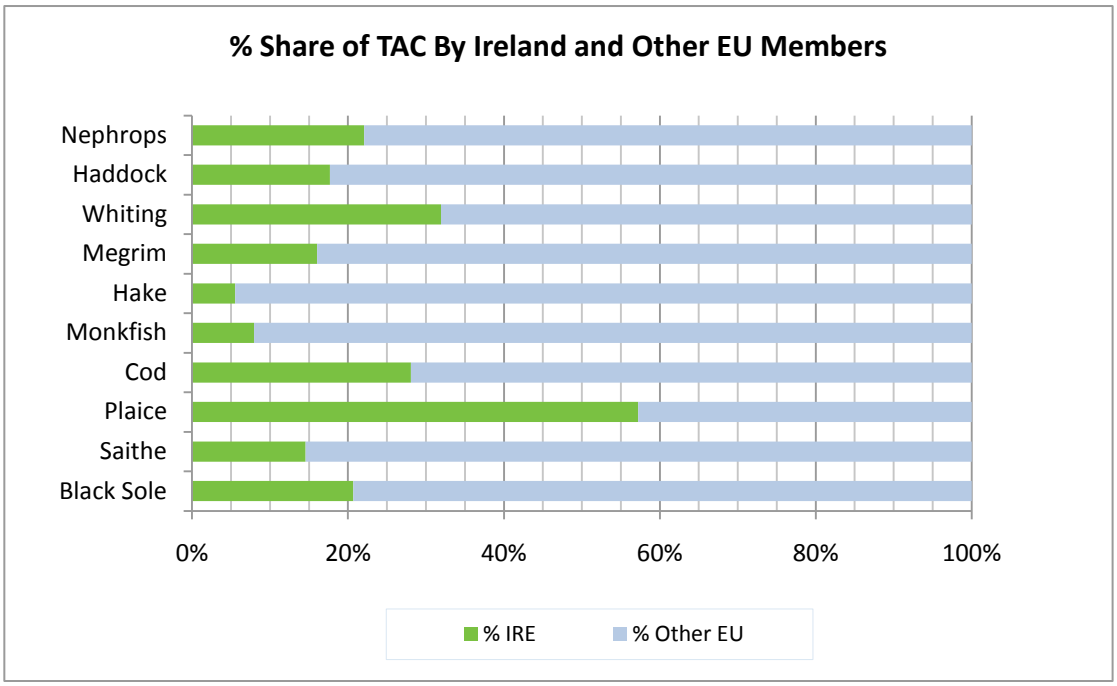


Figure 1.5 Ireland's proportional share of TAC of the top 10 most economically important commercial demersal species in the waters around Ireland in which Ireland has a TAC allocation.

Why Monitor Discarding?

Discards are monitored for a variety of reasons. Scientific stock assessments require data on how much fish has been caught (landings + discards) and the age composition of these catches to conduct accurate stock assessments. The Data Collection Framework (Council Regulation (EC) No 199/2008) mandates extensive and structured discard sampling programmes primarily for that purposes. Increasingly discard data has other uses. For example, vessels in both the Irish Sea and West of Scotland have demonstrated through the use of data collected by the MI and BIM that cod catches are below levels where they are exempted from the effort regime under the cod long-term management plan (CLTMP; EC regulation 1342/2008). Discard data are also an important input to evaluations for the various international certification schemes aimed assuring consumers of fisheries products that they are sustainably sourced.

In Ireland, as in other European countries, up until now it has not been mandatory for fishers to record the volume and species discarded in logbooks. However, since July 2011 it has become mandatory for all vessels to record all species discarded >50kg for each fishing trip under new EC legislation (EC 1224/2009 and EC 404/2011).

Stock assessments require accurate data on how much fish has been caught (landed + discarded) and their age composition. Information from EC logbooks, filled out by all fishermen, together with market sampling, provide data on the fish landed. However this is only part of the total catch. As some of the catch is discarded due to economic or legislative reasons, it is necessary to monitor and quantify discards at sea.

2 Overview of the Irish Catch Sampling Programme

The demersal catch sampling programme conducted by the Marine Institute (MI) is carried out using a combination of port based and at sea sampling methods. Previous programmes have been carried out since the early 1960's, but the focus was on port sampling only (i.e. landings). The combined port and sea based sampling programme (catch) commenced in 1993 and has one of the longest time series of discard data in Europe.

The initial work undertaken between 1993 and 1994 focused on developing the new methods required for monitoring discard and landings in Ireland. Sampling was based according to the trawl fleet activity in each port. In 1995 the standardised fleet discard monitoring programme commenced.

Gear type, areas and season can all have an influence on catches and therefore discards. It is therefore important that programmes to monitor landings and discards cover all the main fisheries. In this context, fisheries are defined as a group of vessel targeting the same species, using similar gear, during the same period of the year and within the same area e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea. A group of vessels engaged in a fishery e.g. twin-rig trawlers targeting *Nephrops* using an 80mm mesh in the Irish Sea, is known as a métier. This is a very important concept in the sampling of discards. In Ireland, over 50 individual trawl métiers have been identified [8]. In 2003, the Marine Institute revised the focus of the catch sampling programme to a more fleet based approach (i.e. métier approach) to better serve the Data Collection Regulation (EC No. 1639/2001).

The métiers chosen for the Marine Institute's catch sampling programme are based on a number of factors. Firstly, it is based on the effort (métier activity i.e. hours fished) and the sampling (no. of trips) is structured in order to be representative of the métier activity. The effort distribution of Irish Vessels by gear type derived from Vessel Monitoring Systems (VMS) data (**2005-2009**) and the distribution of effort from discard sampled trips (**1995-2009**) are shown in Figure 2.1. The observer sea sampling trips (*left side maps*) reflect the Irish vessel activity (*right side maps*). These show that the observer programme effort coverage corresponds well with the effort and distribution of the Irish Fleet.

Other factors considered when choosing métiers to sample include resource constraints (i.e. availability of MI staff), relative importance of the métier to the Irish fishing industry, emerging fisheries (i.e. new métiers) and or fisheries with special considerations (e.g. boats using grids in the Irish Sea).

For both the port based and sea based sampling, the Marine Institute divides the Irish coast into five broad areas; the Celtic Sea, Irish Sea, West of Ireland, West of Scotland and Rockall. Within each of these areas, a number of ICES Divisions and métiers may exist and this is used as the basis for the data presentation in this atlas.

Fishery: *a group of vessels targeting the same species, using similar gear, during the same period of the year and within the same area e.g. the flatfish-directed beam trawl fishery in the Irish Sea.*

Métier*: Homogeneous Sub-division of a fishery by vessel type, gear and catch composition (e.g. the Irish flatfish-directed beam trawl fishery by vessels < 300 hp in the Irish Sea). See Appendix 1 for detailed métier description as defined in the atlas.*

Target Species: *A list of species targeted in a métier, for example otter trawls (OTB) may target demersal species such as haddock and whiting. Gillnets (GNS) may target demersal species such as saithe, ling, and pollack; cod; rays; hake and forkbeard. Beam Trawls (TBB) may target species, like ray and flatfish species, or megrim, monkfish, witch and lemon sole. See Appendix 1 for detailed métier description and their associated target species.*

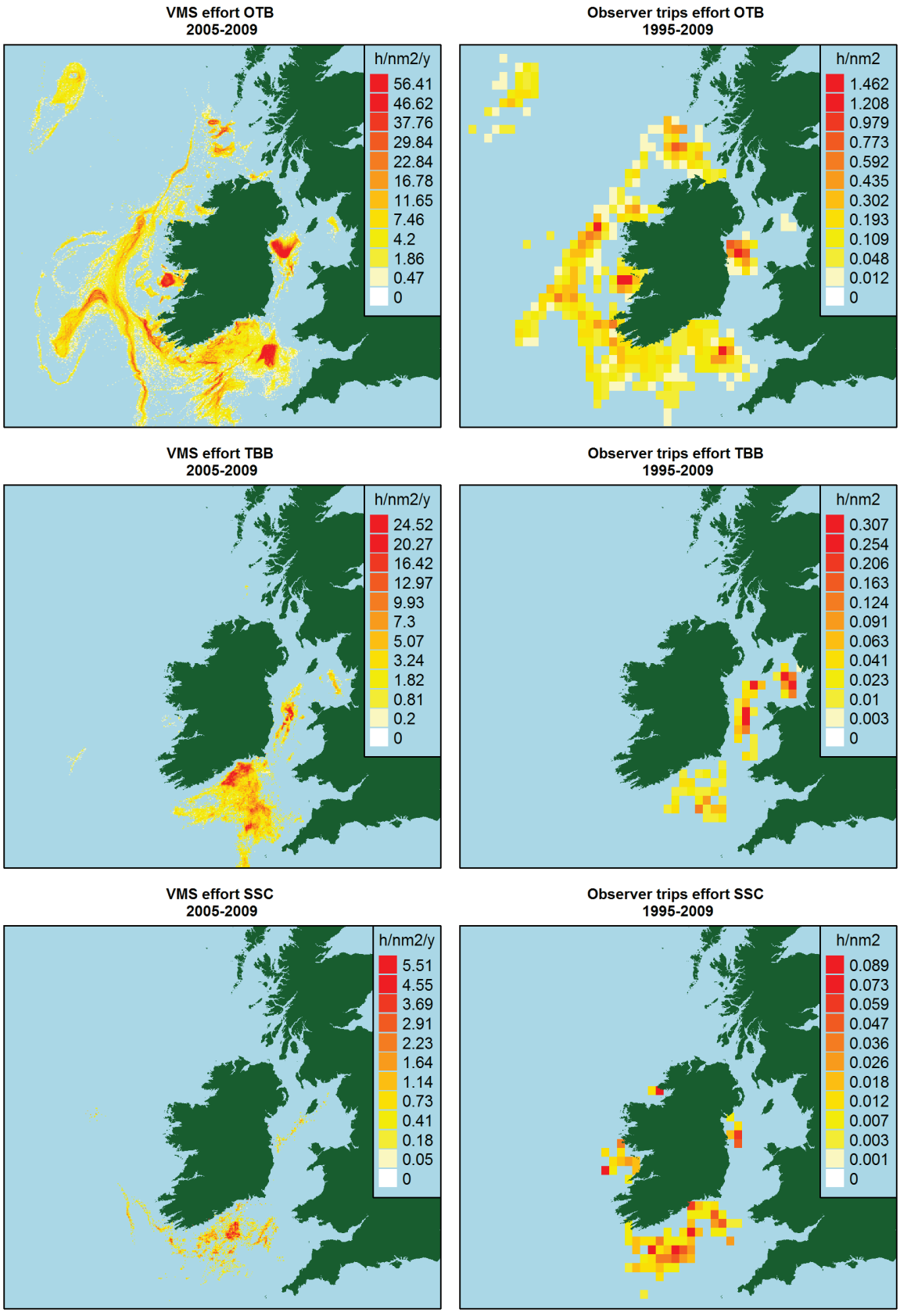


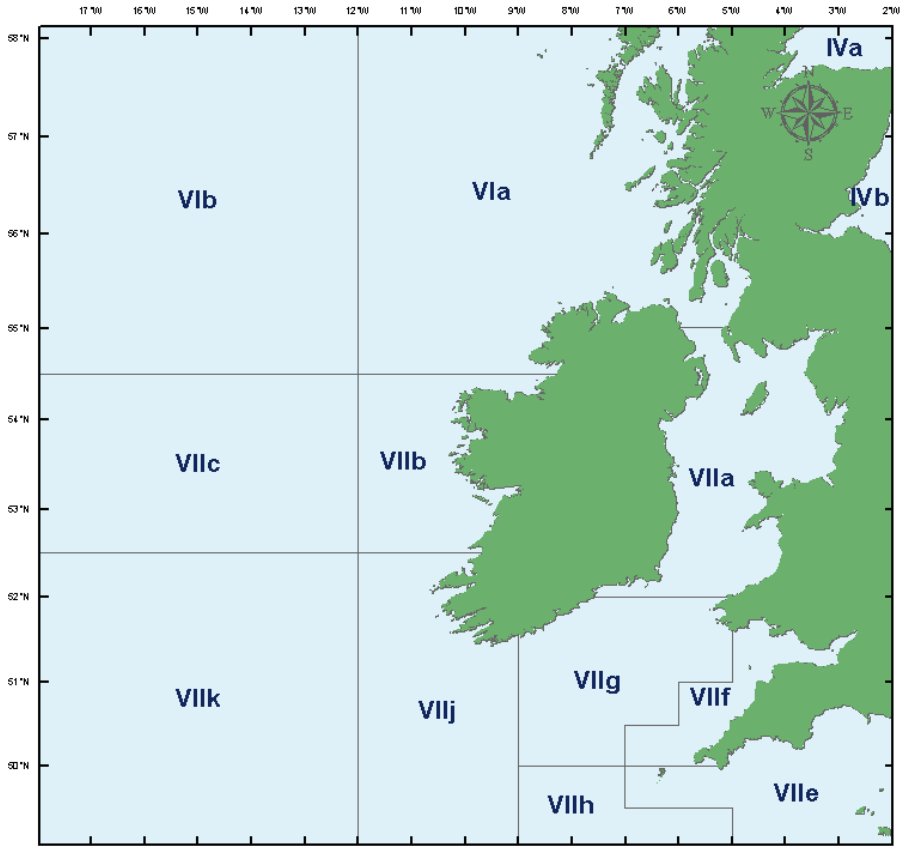
Figure 2.1 **Effort distribution of Irish Vessels by gear type from VMS database 2005-2009** (*left side maps*) **and from discard sampled trips (1995-2009)** (*right side maps*). **SSC – Scottish Seine Net; TBB – Twin Beam Trawl; OTB – Demersal Otter Trawl. The scales show fishing intensity per year in terms of the hours fished per square nautical mile per year. The maps on the left show the effort of the >15m commercial fleet; the right hand maps show the amount of effort on observed sampling trips.**

A three part short code is used to define each of the métiers in this Atlas– these relate to:
Gear Type_ ICES Division_ Target Species where:

Gear Type:

- OTB – bottom otter trawl; SSC – Scottish Seine; TBB – Twin Beam Trawl; GNS – Gill Nets;

ICES Division:
Below is map showing the ICES divisions (VIb, VIa, VIIb etc.) in the waters around Ireland.



Target Species
"Dem" – demersal fish; "Neph" – *Nephrops;* "Meg & Monk" – Megrim and Monkfish

A more detailed description of the métiers used for the data presentation in this atlas can be found in appendix 1.

The numbers of trips within each area and subsequently within each métier sampled between 2003 and 2009 are shown in Table 2.1. The distribution of the sampled métiers of the Irish catch sampling programme within each area are shown in Figure 2.2.

How is data collected?
During a typical catch sampling trip, data is collected on the gear type used, fishing ground, weather conditions, species catch composition and quantity of the landings and discards in the catch.

Data on the length, weight and age composition of each discarded species is collected as well as length data for the landed species. A sample of discards (D_h), typically a 40 kg box, is randomly collected per haul and all fish species are identified and measured. The proportion of non-fish discards present in the box is also recorded. The total discards (D) for the haul are estimated by subtracting the total landings (L) from the total catch (C) for that haul.

Total Discards (D) per haul = Total Catch (C) per haul - Total Landings per haul (H)

The sample (D_h), is then raised up to total discards for that haul using the ratio of D/ D_h.
The total discards for the observed trip can then be estimated and further raised to fleet level.

There are many different ways to raise catch data from the sampled level (i.e. an individual fishing trip) to fleet level (all trips).
Data can be raised either using effort or total landings.

(i) **Raising by effort:** can be done in a number of ways for example hours fished, days fished and the number of trips carried out.
(ii) **Raising by landings:** can be done using total landings of all species or total landings of individual species.

Each of the different ways of raising the data will give different results depending on the appropriateness of the raising method used for a particular métier. The most appropriate method is one that reduces variability (error) in the data.

The data in the atlas was raised using landings i.e. total landings of all species in the fleet. Raising to fleet level for the métier based analysis presented in the atlas has only been possible since 2003 as then more detailed data (e.g. mesh size) was made available. The source of this landings data is from the Irish Logbook database. For the purpose of the atlas, the data presented in the tables in Chapter 3 was raised to fleet level using landings.

- **Tables (Raised data)**

The data presented in the **tables** in Chapter 3 are **raised to the fleet level,** using landings from that fleet. These represent a total of 398 trips covering 17 métiers sampled between 2003 and 2009.

- **Maps (Unraised data)**

Since 1995 a total of 613 trips have been sampled. The data from these sampling trips (1995-2009) are presented in the **maps** shown in Chapter 3. **It should be noted here that these maps are based on sampling level only and are not raised to the overall fleet**. Therefore the information (landings, discards etc) presented shows the summed catches from **observer trips only**.

Table 2.1 Number of métiers sampled by Ireland between 2003 and 2009.

Area	Métier	2003	2004	2005	2006	2007	2008	2009	Total
Celtic Sea	GNS VIIbcgjk Dem							3	3
	OTB VIIgfh Neph	3	2	3		10	7	10	35
	OTB VIIj Neph	3	2	2			1	1	9
	SSC VIIgj Dem	3	5	3		4	3	4	22
	TBB VIIefgh Dem					1	2	3	6
	OTB VIIfgjk Dem	10	18	16	4	8	11	9	76
Irish Sea	OTB VIIa Dem	3	2						5
	OTB VIIa Neph	7	10	8	5	15	17	9	71
	SSC VIIa Dem					1	1		2
	TBB VIIa Dem					3	3	3	9
Rockall	OTB VIb Dem				1	1	2	1	5
West of Ireland	OTB VIa VIIbcjk Meg & Monk	7	24	16	2	11	14	16	90
	OTB VIIb Neph	6	6	4	2		8	5	31
	OTB VIIbc Dem	2	1	1		2	2	4	12
	OTB VIIck Neph					2	1	2	5
West of Scotland	OTB VIa Dem	2	2	3		2	5	1	15
	OTB VIa Neph	1		1					2
	Total Trips	**47**	**72**	**57**	**14**	**60**	**77**	**71**	**398**

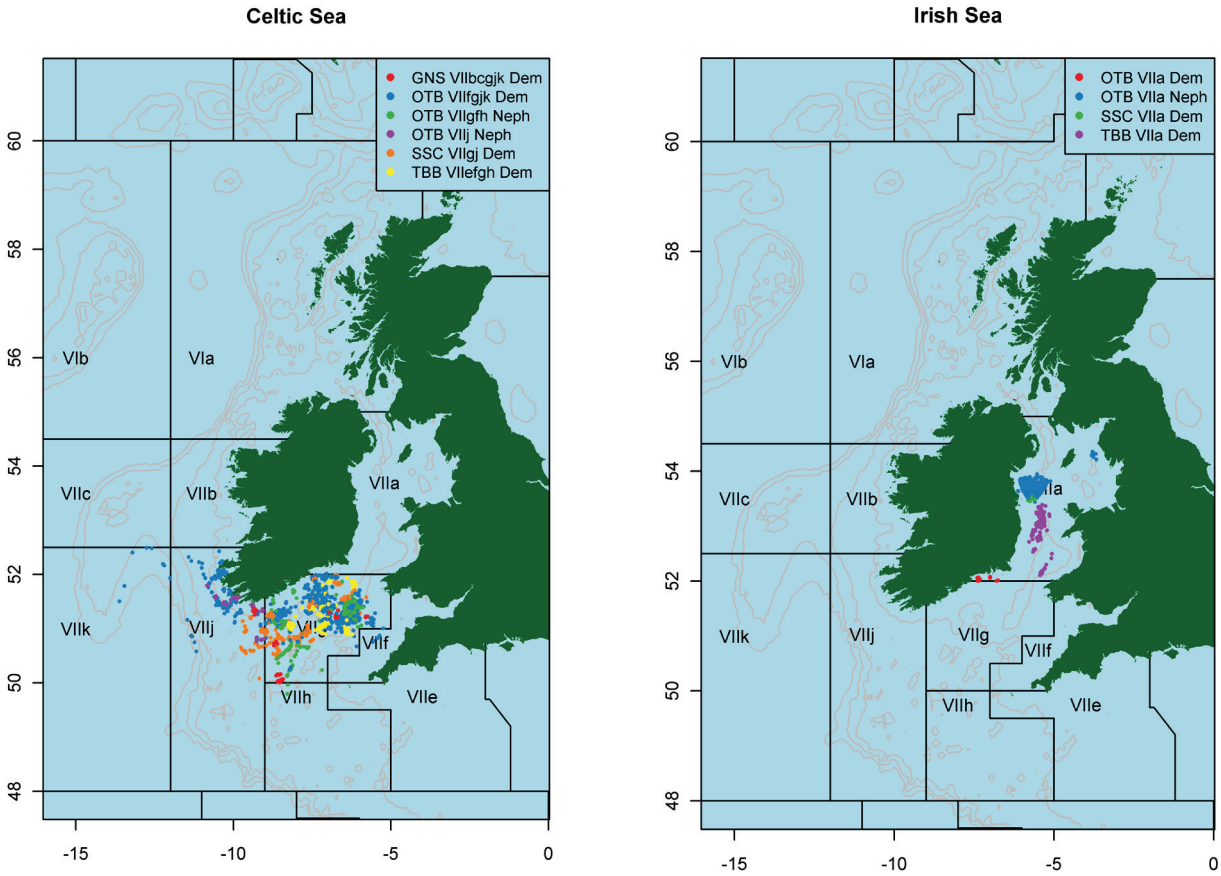


Figure 2.2 Maps of the Areas showing the distribution of hauls sampled by métier (2003-2009).

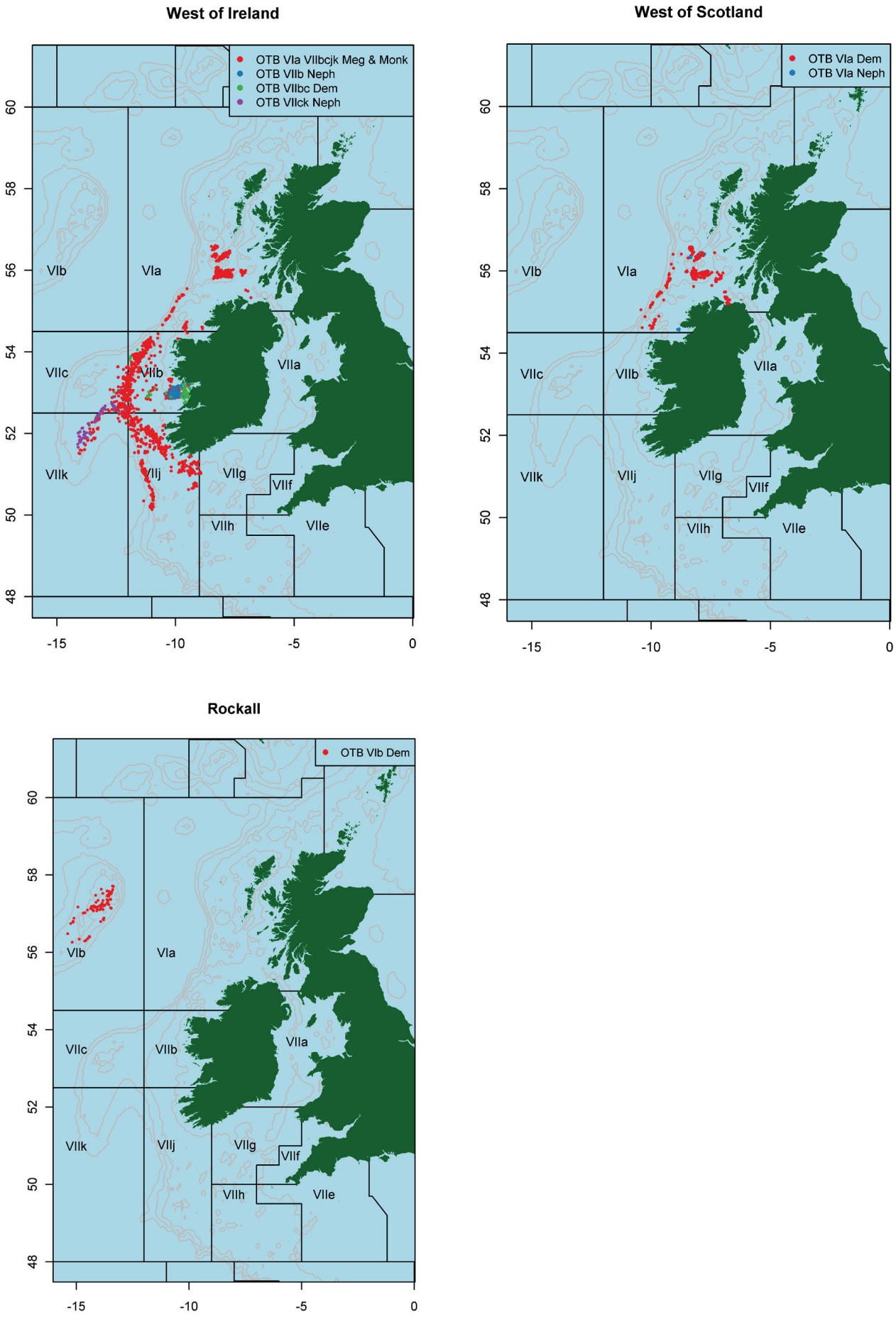


Figure 2.2 cont'd **Maps of the Areas showing the distribution of hauls sampled by métier (2003-2009).**

3 DISCARDING PATTERNS IN IRISH FISHERIES

Discarding is a complex issue, involving numerous fish species, both commercial and non commercial and non-fish species, e.g. crabs and sea-weed. For ease of interpretation, this section describes the discarding pattern for the top 10 commercial and non-commercial species in Irish demersal fisheries. The data is presented in two formats, maps and tables. The maps provide an overview of spatial discard patterns. The tables provide a more detailed look of discarding levels by area, gear and target species.

Overviews of the discarding associated with the 'top 10' demersal commercial and non-commercial species are presented in Tables 3.1 and 3.2.

The top 10 commercial species landed (Table 3.1) are defined as those species with the highest landed weight as recorded in the Irish discard sampling programme and the data is subsequently raised to fleet level. The table provides the total catch, landings and discards by weight (in tonnes) over the period 2003 – 2009.

The top 10 non-commercial fish species landed (Table 3.2) are defined as those species with the highest discarded weight as recorded in the Irish discard sampling programme and the data is also raised to fleet level. The raised landings and discard data presented relates specifically to identified demersal fleets and no data from pelagic métiers is included.

Commercial Fish Species: *Here commercial species are defined as those that have an established commercial value in demersal fisheries e.g. Nephrops, cod, haddock, whiting, plaice, megrim, black sole.*

Non Commercial Species: *Here we define non-commercial species where >95% of the catch is discarded by demersal gears. It should be noted that several of the species are targeted in pelagic fisheries e.g. boar-fish, argentine, blue whiting, but in general these are not landed by demersal vessels. For some of the species, a small amount of landings are reported, but this is typically for pot bait.*

Between 2003-2009, the 'top 10' Irish commercial species produced an average catch of 36,600 tonnes per year with associated discards of at least 14,000 tonnes per year in Irish demersal fisheries, giving an average discard rate of 38% per annum. It is important to note that the discard rate of commercial species has declined between 2003 and 2009 (Figure 3.1) mainly due to the introduction of new technical measures, reductions in fishing effort associated with the long term management plan for cod, national decommissioning schemes (2006 & 2008) and changes in commercial fishing patterns. Over the same period, the Irish fleet discarded at least 7,200 tonnes per year of the 'top 10' non commercial fish species.

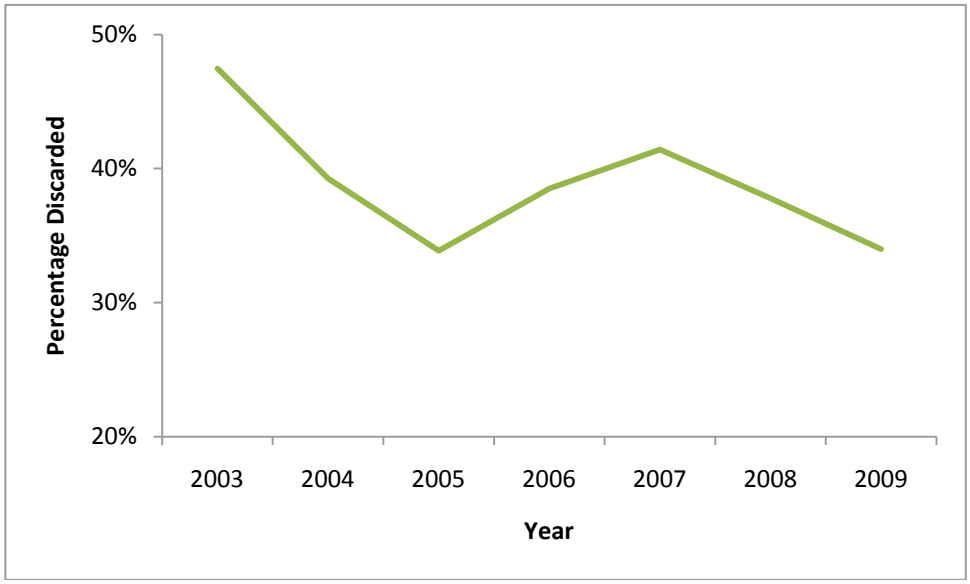


Figure 3.1 Percentage discard rate of the 'top 10' commercial species.

Table 3.1 Top 10 Commercial Fish Species Landed (by weight) from 2003-2009 Caught by Demersal Gears.

Species	Discards	Landings	Total Catch	Discard Rate	*Annual Average Discarded*
Nephrops	11,194	51,808	63,312	18%	1,599
Haddock	34,532	28,773	63,306	55%	4,933
Whiting	23,246	19,410	42,656	54%	3,321
Megrim	6,230	14,902	21,132	29%	890
Hake	6,521	12,422	18,942	34%	932
Monkfish	2,756	12,276	15,032	18%	394
Cod	1,140	8,848	9,988	11%	163
Plaice	9,912	3,973	13,885	71%	1,416
Saithe	468	2,963	3,430	14%	67
Witch	2,278	2,271	4,549	50%	325
Total	98,277	157,645	255,922	38%	14,040
Annual Average	14,039	22,251	36,560		

These data are presented in pages 20 to 39.

Table 3.2 Top 10 Non-Commercial Fish Species (by weight) from 2003-2009 Caught by Demersal Gears.

Species	Total Catch	Discard Rate	*Annual Average Discarded*
Lesser Spotted Dogfish	12,863	100%	1,835
Grey Gurnard	12,211	100%	1,744
Dab	5,973	100%	853
Blue Whiting*	5,244	100%	749
Forkbeard	3,255	100%	463
Poor Cod	3,031	100%	433
Scad*	2,820	100%	403
Boar-fish*	2,086	100%	298
Argentinidae*	1,890	100%	270
Long Rough Dab	1,292	100%	185
Total	50,665		7,238
Annual Average	7,238		

These data are presented in pages 40 to 59.

*These species are targeted in pelagic fisheries without significant discards.

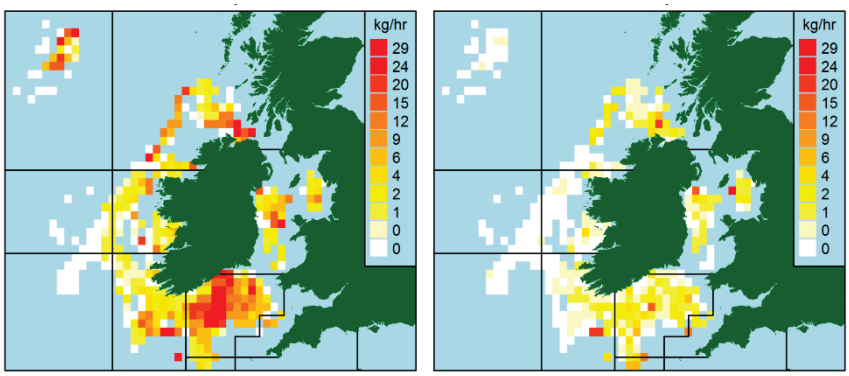
While the tables above provide an aggregated view of landings and discards for the most important demersal métiers, several of the commercial species belong to different stocks and are also caught by a wide range of métiers. In order to provide a more detailed and thorough review of discarding practices and distribution, for each of the species identified above maps and tables are provided showing where discarding occurs and what métiers are involved.

How to interpret the maps:

The maps presented in Figures 3.2 to 3.22 show the data observed from discard trips carried out between 1995-2009. They represent sampled data only. The intention is to give an overview of spatial discard patterns around the Irish coast and **should not be interpreted as absolute values of discards.** The catch and effort data relate only to the actual observed trips and are not raised to the total fleet level.

All maps show the total amount of sampling effort (square nautical miles covered in year) undertaken by the Marine Institute discard sampling aggregated from **1995 to 2009**. The maps are intended to give a broad overview of patterns. It is important to note that this analysis includes all gears (although the vast majority of data are for otter trawlers) nor have catch or effort been corrected for vessel, season, year or the many other factors that might influence the catch composition.

All legends use a sliding scale in colour from red to white (*see example on the following page*) where red represents the highest value on the scale and white represent the lowest value on that scale. **Note that the scale changes across species**.



When interpreting discard information it is very important to consider several variables together. The top two panels of the maps show the **cumulative observed landings (kg) and discards (kg)** in each cell on a similar scale. Note that the landings and discards are the total weights from the observed trips only and therefore should not be used as absolute estimates. These are intended to allow the reader to quickly see landings and discard hotspots for each species in terms of total volume.

These data are then standardised in the middle two panels by the cumulative amount of effort (hours fished) during observed trips in each cell to show a view of the **landings and discard per unit effort** on a similar scale. The bottom panels give the proportion of each species discarded in each cell and the total effort from observer trips.

Total observed landings
These maps display the cumulative landings from all the observed hauls in each cell or pixel (approximately 12x12 nm^2) by species. This gives an indication of the spatial distribution of the landings of that species on observed trips. Landings are as recorded on commercial landings tally sheet for each haul observed.

Total observed discards
Similarly the maps of total discards show the cumulative weight discarded of each species for all hauls in each cell.

Observed Landings Per Unit Effort (LPUE)
These maps show the landings per unit effort (Kg per hour) of the vessels sampled. This allows the landings to be standardized amongst trips and gives a boarder indication of the levels of landings for that species. LPUE provides perspective for the "total observed landings" and is a better way to show the relative abundance or density of fish. The amount of fish landed or caught in a given area is dependant on the density of the fish in the area and the amount of fishing effort. Areas with high densities and low effort can produce similar catches to areas of low densities but high effort. Using catch rates standardised by the amount of effort, gives a better view of the density and abundance of fish across areas.

Observed Discards Per Unit Effort (DPUE)
Similarly, high catches of unwanted fish can be associated with fishing in areas with high densities of 'small' fish even with low levels of effort, conversely, high effort in areas with relative low abundance of unwanted fish can result in similar discard levels. If we want to identify areas which have high levels of small or non-commercial species, it is important to provide a standardised measure. The maps show the discard of the species per unit effort (Kg per hour). This allows the discards to be standardized amongst trips and gives a broader indication of the levels of discards for that species. LPUE provides perspective for the "total observed discards"

Proportion discarded by weight
The maps display the proportion discarded of overall catch (landings + discards) for that species.

Total observed effort
The maps display the effort in hours fished by sampled vessels aggregated across all sampled trips.

How to interpret the tables:

The species data presented in the Tables 3.3 to 3.22 (see *example below*) are given by area and by métier. Area is defined as broad fishing regions around the coast of Ireland (see Chapter 2). Métier is the sampling basis used. Each table outlines the data sampled by métier raised to fleet level for the period **2003-2009**. **The data is raised using total landings as the raising variable** (see Chapter 2). Values therefore are an indication of the absolute levels of discarding and landings between 2003 and 2009.

Discards is the total weight in tonnes discarded between 2003-2009, raised to fleet level.

Landings is the total weight in tonnes landed between 2003-2009, raised to fleet level.

Total Catch is equal to the weight of both landings and discards above.

The **Discard Rate** for a given species refers to the Percentage of the catch discarded.

Discard Rate = Discards (tonnes) / Total catch (tonnes) X 100

In the example below, the discard rate for Haddock in the SSC VIIgj Dem métier is 48%. This was calculated by dividing the Discards (5,263.6 tonnes) by the Total catch (10,941.3 tonnes).

The **percentage contribution** is the relative contribution that discards weights by individual métiers make to the overall discards in the area. This gives an indication of the relative importance of particular métiers to the overall discarding within an area. This ranking could be used as the basis to select priority métiers, where reducing discards would lead to an improvement in stock status by lowering fishing mortality. In each table the métiers with the highest relative importance are highlighted.

In the example below the **Total Discards** for Haddock in the Celtic Sea area was 15,798.9 tonnes (circled). The **Discards** for the OTB VIIfgjk Dem métier were 6,902.7 tonnes (circled). This volume of discards amounted to 44% (circled) of the total haddock discards in the area. This was calculated by dividing the Discards of the OTB VIIfgjk Dem métier (6,902.7 tonnes) by the Total Discards of the area (15,798.9 tonnes).

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	OTB VIIfgjk Dem	6,902.7	8,624.2	15,526.9	44%	**44%**
	SSC VIIgj Dem	5,263.6	5,677.7	10,941.3	48%	**33%**
	TBB VIIefgh Dem	1,816.0	1,059.5	2,875.5	63%	**11%**
	OTB VIIgfh Neph	1,480.2	462.6	1,942.8	76%	**9%**
	OTB VIIj Neph	331.9	123.3	455.3	73%	**2%**
	GNS VIIbcgjk Dem	4.5	103.9	108.4	4%	**0%**
	TOTAL	**15,798.9**	**16,051.2**	**31,850.1**	**50%**	

It is important to note that the degree of improvement to any given stock that could be gained by improvements in selectivity of Irish vessels is dependent on the share that Ireland has of the international catches. While the rate of discards varies across individual member states due to differences in gear selectivity and quota allocation, if the total catch is even broadly similar to the quota allocation, the relative contribution Ireland makes to discards will be approximately one quarter. This varies from a fraction of a percentage (e.g. VIa cod) to ~30% of haddock discard in the Celtic Sea (see page 6 also).

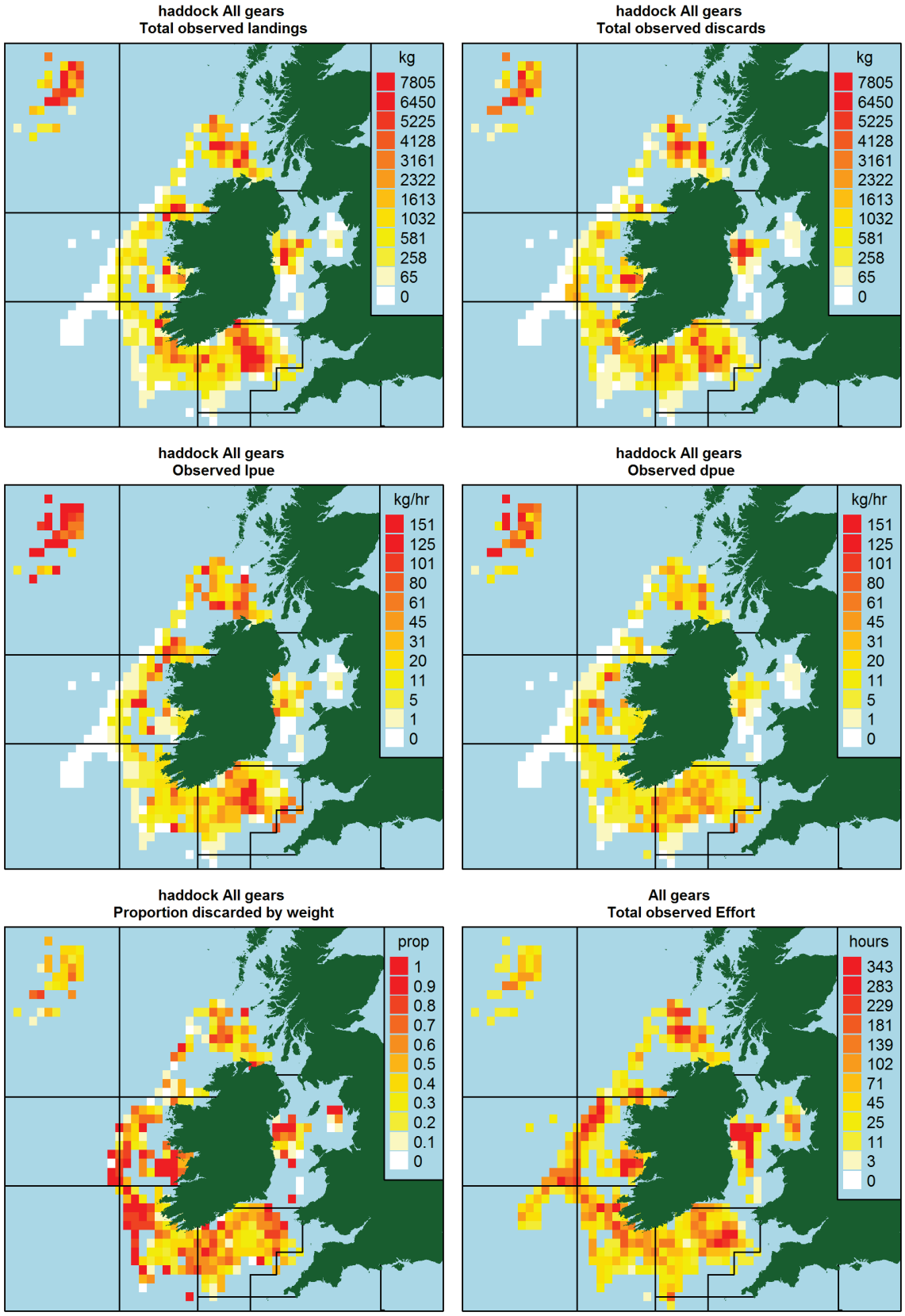


Figure 3.2 **Observed Haddock Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Along with whiting and monkfish, haddock is one of the most important demersal species landed by Irish vessels. Haddock landings are predominately associated with the Celtic Sea, west of Scotland, the Irish Sea and Rockall. High landings also occur in the Celtic Sea in the Smalls fishing grounds (see appendix II for map of Irish fishing grounds). This pattern is also reflected in the LPUE. Discarding levels are high in the three main areas and a high proportion of haddock caught are discarded all around the coast.

Table 3.3 Total Haddock Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	OTB VIIfgjk Dem	6,902.7	8,624.2	15,526.9	44%	**44%**
	SSC VIIgj Dem	5,263.6	5,677.7	10,941.3	48%	**33%**
	TBB VIIefgh Dem	1,816.0	1,059.5	2,875.5	63%	**11%**
	OTB VIIgfh Neph	1,480.2	462.6	1,942.8	76%	**9%**
	OTB VIIj Neph	331.9	123.3	455.3	73%	**2%**
	GNS VIIbcgjk Dem	4.5	103.9	108.4	4%	**0%**
	TOTAL	**15,798.9**	**16,051.2**	**31,850.1**	**50%**	
Irish Sea	OTB VIIa Neph	3,625.8	343.4	3,969.2	91%	**71%**
	SSC VIIa Dem	1,107.7	650.5	1,758.2	63%	**22%**
	OTB VIIa Dem*	347.9	515.0	862.9	68%	**7%**
	TBB VIIa Dem*	2.3	65.2	67.5	.03%	**0%**
	TOTAL	**5,083.6**	**1,574.1**	**6,657.8**	**76%**	
Rockall	OTB VIb Dem	2,918.5	3,314.0	6,232.5	47%	**100%**
	TOTAL	**2,918.5**	**3,314.0**	**6,232.5**	**47%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	6,526.7	2,956.7	9,483.4	69%	**71%**
	OTB VIIbc Dem	1,838.2	2,000.8	3,839.0	48%	**20%**
	OTB VIIb Neph	835.9	231.7	1,067.6	78%	**9%**
	TOTAL	**9,200.8**	**5,189.2**	**14,390.0**	**64%**	
West of Scotland	OTB VIa Dem	1,502.3	3,216.8	4,719.1	32%	**98%**
	OTB VIa Neph	28.3	8.1	36.4	78%	**2%**
	TOTAL	**1,530.6**	**3,224.9**	**4,755.5**	**32%**	

*Landings values derived from Logbook data

Key Observations for Table

High discarding rates are observed in almost all métiers, although the relative contribution made to overall discard levels is highly variable. Analysis of the discard rates and the relative contribution each métier makes to the absolute levels within areas is noteworthy. In the Celtic Sea, many of the *Nephrops* targeted métiers have very high discard rates e.g. OTB VIIgfh Neph, OTB VIIj Neph, typically greater than 70%. This is presumably due to the smaller mesh size used to target *Nephrops*. However, their overall contribution to absolute levels of haddock discards is proportionally small, less than 11% (9% for OTB VIIgfh Neph and 2% for OTB VIIj Neph) of haddock discards in the Celtic Sea area can be attributed to these. Generally, it is the targeted métiers for haddock that have the greatest contribution to haddock discards in their area. An example of this is the OTB VIIfgjk Dem which has a discard rate of 44% and a contribution of 44% and also the SSC VIIgj Dem métier has a discard rate of 48% and an overall contribution of 33%. In the West of Ireland there was an overall discard rate of 64%, with the OTB VIa VIIbcjk Meg & Monk contributing to 71% of the haddock discards. Furthermore in Rockall a discard rate of 47% was observed.

Key Observations for Haddock Discarding Practices

Discarding of haddock is predominately associated with the capture of small unmarketable/undersize fish. Discard levels could be significantly reduced through alterations in mesh size and/or the use of a square mesh panel in areas where they are currently unused. It should be noted that changes in selectivity will have a greater impact on associated whiting catches. This will significantly improve the sustainability of the stock.

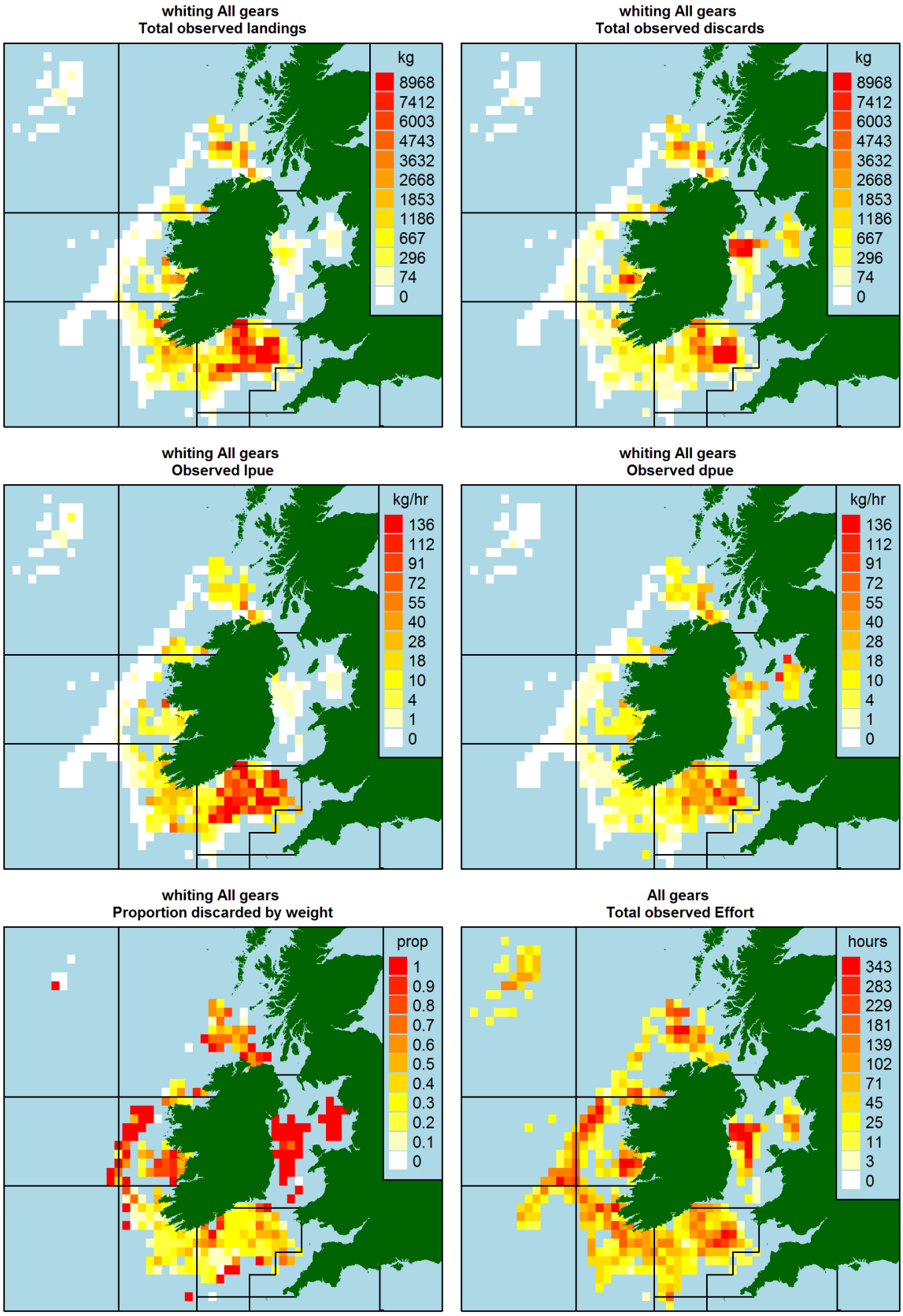


Figure 3.3 **Observed Whiting Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

In general whiting landings are high. The most prominent area for landings of whiting was off the South coast in the Celtic Sea. Observed LPUE plots show a similar pattern, with values of between 55-136 kg per hour. The discard pattern shows high discards off the south east coast and in the Irish Sea, where almost all whiting caught are discarded and there are no whiting landings, Discarding in other areas were generally low. Total observed discards were higher in the eastern Irish Sea, reflecting the high discarding of whiting in the *Nephrops* fishery. The proportion discarded by weight indicates that more that 50% of whiting caught are discarded with the highest levels observed in the Irish Sea.

Table 3.4 Total Whiting Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	OTB VIIfgjk Dem	5,656.9	9,986.4	15,643.3	36%	**45%**
	SSC VIIgj Dem	2,472.8	5,650.2	8,123.0	30%	**20%**
	OTB VIIgfh Neph	4,124.6	953.7	5,078.3	81%	**33%**
	TBB VIIefgh Dem	248.2	34.0	282.2	88%	**2%**
	OTB VIIj Neph	103.3	31.1	134.5	77%	**1%**
	GNS VIIbcgjk Dem	13.4	11.7	25.1	53%	**0%**
	TOTAL	**12,619.3**	**16,667.1**	**29,286.3**	**43%**	
Irish Sea	OTB VIIa Neph	5,847.5	7.8	5,855.3	100%	**89%**
	OTB VIIa Dem*	424.0	362.0	786.0	54%	**6%**
	SSC VIIa Dem	201.1	2.8	203.9	99%	**3%**
	TBB VIIa Dem*	70.2	9.1	79.3	89%	**1%**
	TOTAL	**6,542.8**	**381.7**	**6,924.5**	**94%**	
Rockall	OTB VIb Dem		1.8	1.8	0%	
	TOTAL		**1.8**	**1.8**	**0%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	1,339.5	916.9	2,256.4	59%	**48%**
	OTB VIIbc Dem	782.5	648.1	1,430.6	55%	**28%**
	OTB VIIb Neph	642.3	185.7	828.0	78%	**23%**
	TOTAL	**2,764.3**	**1,750.7**	**4,514.9**	**61%**	
West of Scotland	OTB VIa Dem	1,203.4	978.4	2,181.8	55%	**91%**
	OTB VIa Neph	116.3	1.3	117.5	99%	**9%**
	TOTAL	**1,319.7**	**979.7**	**2,299.3**	**57%**	

*Landings values derived from Logbook data

Key Observations for Table

The two métiers with the highest catch (landings and discards) of whiting were observed in the Celtic Sea, the OTB VIIfgjk Dem and the SSC VIIgj Dem métiers. These two métiers contributed 45% and 20% to the discarding of the whiting in the Celtic Sea. The OTB VIIgfh Neph contributed 33% to the discards of whiting in the Celtic Sea, and had an overall discard rate of 81%. In the Irish Sea, the OTB VIIa Neph métier had significantly higher discards of whiting than other métiers and contributed to 89% of the overall discards in the area.

Key Observations for Whiting Discarding Practices

The majority of whiting discards are associated with the capture of fish below minimum landings size and small legally sized fish. Improvements in mesh selection through increased mesh size and/or the introduction or modification of existing square mesh panels have been well proven to reduce whiting discards.

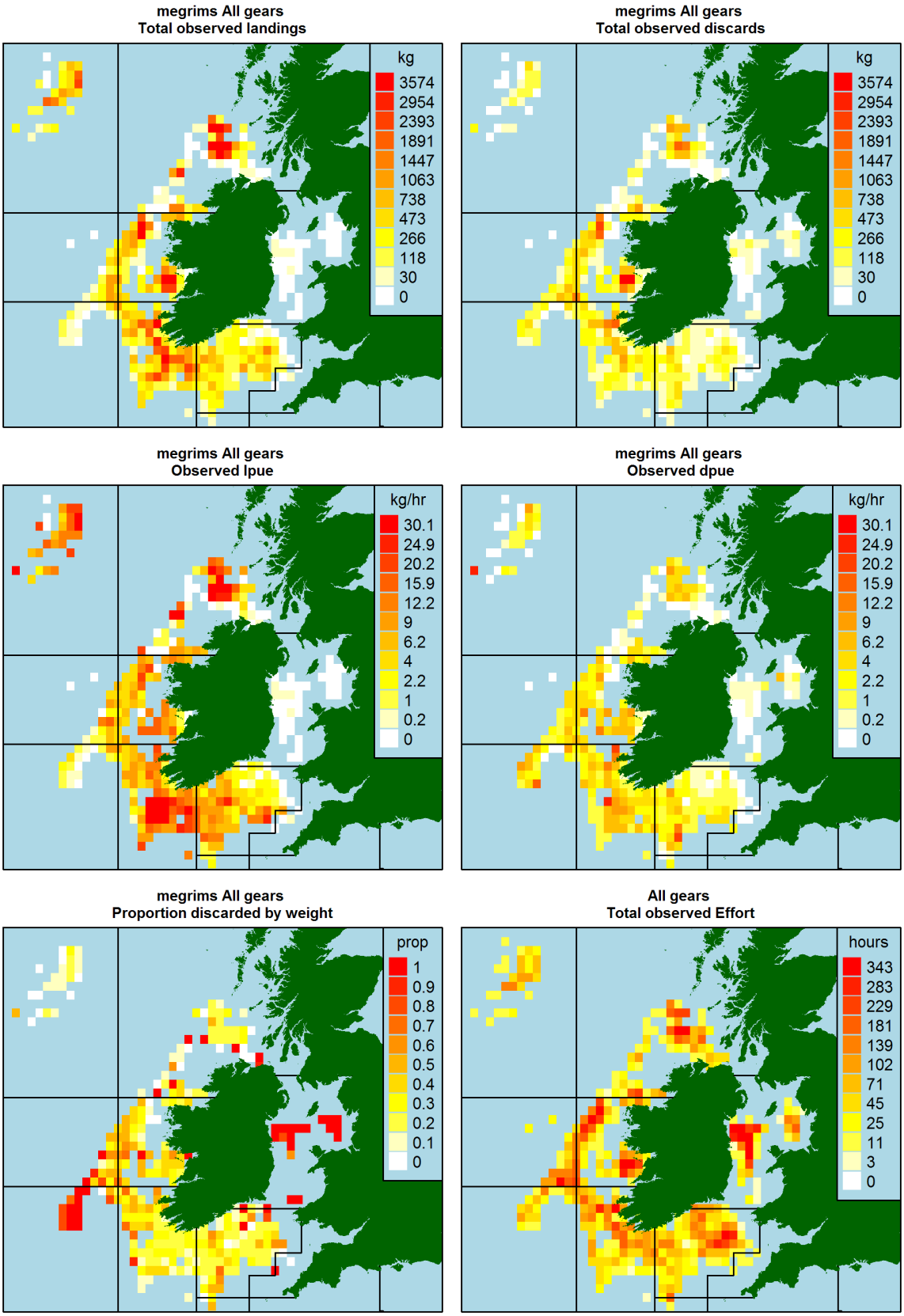


Figure 3.4 **Observed Megrim Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Landings of megrim were observed in most sampled areas, with highest landings observed in Division VIa and lowest levels observed in VIIa, the Irish Sea. LPUE patterns also reflect the landings. Highest LPUE values of between 9-30kg per hour were observed in the southwest coast. With the exception of the Irish sea, megrim discards were observed in all areas. The DPUE pattern reflects the discards pattern with levels ranging from 1-7kg per hour. The proportion discarded by weight was generally greater than 30%, with some areas with elevated discard rates observed, along the Porcupine Bank. High proportions of discards were also observed in the Irish Sea but there were little or no landings of megrim observed in this area.

Table 3.5 Total Megrim Catch in tonnes Catch by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	TBB VIIefgh Dem	1,007.8	2,087.7	3,095.5	33%	**42%**
	OTB VIIfgjk Dem	794.5	1,521.8	2,316.3	34%	**33%**
	OTB VIIgfh Neph	442.4	970.7	1,413.1	31%	**19%**
	SSC VIIgj Dem	62.5	470.5	533.0	12%	**3%**
	OTB VIIj Neph	73.3	178.0	251.3	29%	**3%**
	GNS VIIbcgjk Dem	4.8	34.0	38.8	12%	**0%**
	TOTAL	**2,385.3**	**5,262.7**	**7,648.0**	**31%**	
Irish Sea	OTB VIIa Neph	17.1	1.4	18.5	92%	**85%**
	OTB VIIa Dem*	1.6	34.7	36.3	4%	**8%**
	TBB VIIa Dem*	1.5	47.5	49	3%	**7%**
	TOTAL	**20.2**	**83.6**	**103.8**	**19%**	
Rockall	OTB VIb Dem	29.4	611.2	640.6	5%	**100%**
	TOTAL	**29.4**	**611.2**	**640.6**	**5%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	2,563.4	6,449.1	9,012.5	28%	**72%**
	OTB VIIb Neph	638.7	626.8	1,265.5	50%	**18%**
	OTB VIIbc Dem	296.3	349.0	645.3	46%	**8%**
	OTB VIIck Neph	55.7	5.1	60.8	92%	**2%**
	TOTAL	**3,554.1**	**7,430.0**	**10,984.1**	**32%**	
West of Scotland	OTB VIa Dem	234.8	1,581.8	1,816.6	13%	**97%**
	OTB VIa Neph	6.1	15.0	21.1	29%	**3%**
	TOTAL	**240.9**	**1,596.8**	**1,837.7**	**13%**	

*Landings values derived from Logbook data

Key Observations for Table

This table shows that the majority of megrim discarding takes place in the West of Ireland. This area includes the OTB VIa VIIbcjk Meg & Monk métier which has one of the highest landings and discards of megrim across all métiers and contributes 72% to the overall discarding of megrim in the West of Ireland. Higher discard rates may have been observed in other métiers but they only contributed 28% in total of the remaining discards for the West of Ireland. The TBB VIIefgh and the OTB VIIfgjk Dem métiers had the highest contribution of overall megrim discards in the Celtic Sea at 42% and 33% respectively. Landings and discards of megrim in the West of Scotland, Rockall and the Irish Sea are comparably low.

Key Observations for Megrim Discarding Practices

Megrim is discarded due to the retention of fish below minimum landings size and for quality considerations. There is a strong market preference for undamaged fish. Anecdotal evidence that increases in mesh size in the west of Scotland have increased the level of quality induced discards due to fish becoming stuck in the larger mesh size ('stickers'). While the TBB VIIefgh métier has a high contribution to overall discarding it should be noted that effort in this métier has declined by about 30% since 2006.

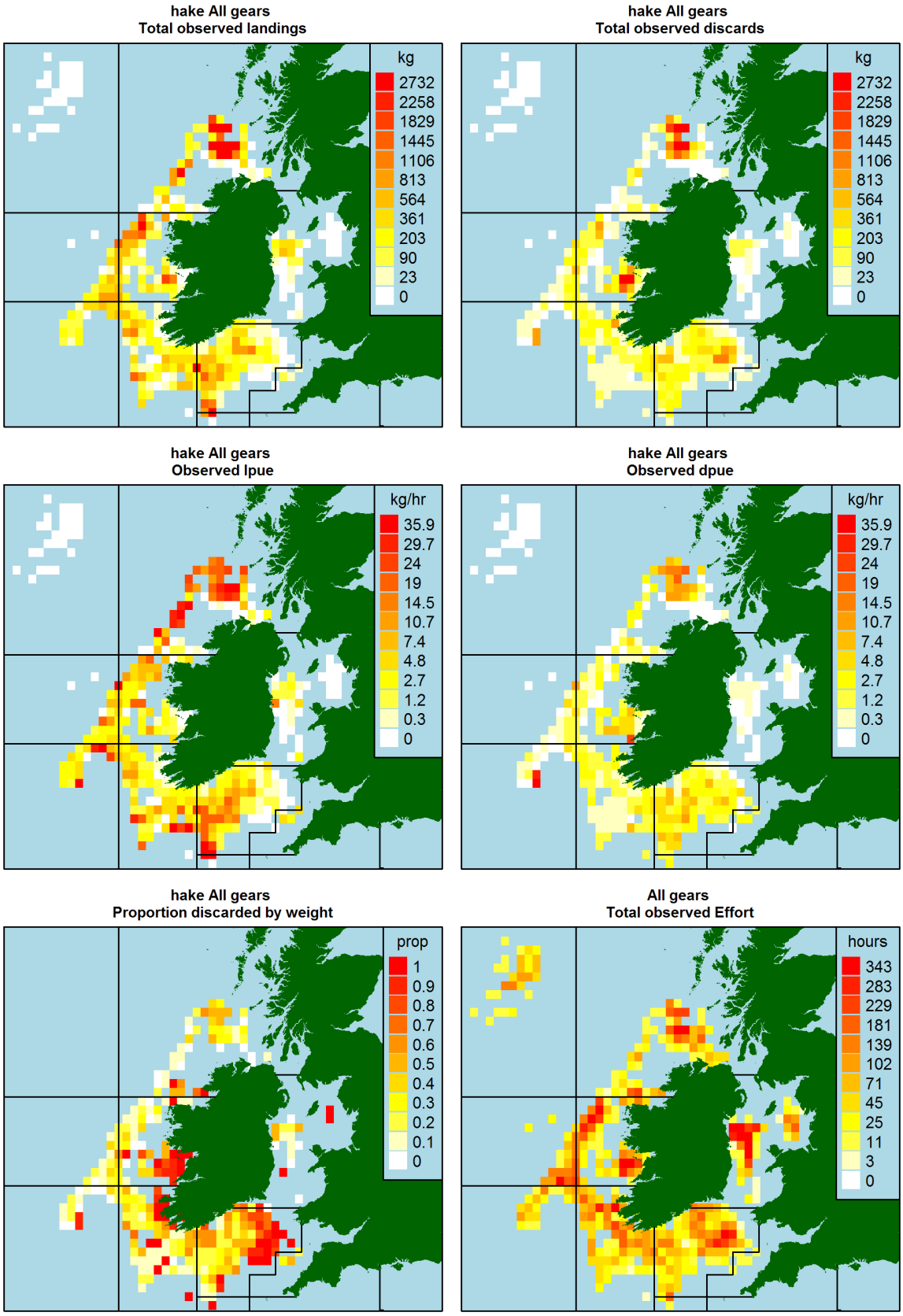


Figure 3.5 **Observed Hake Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Highest observed landings for Hake were in the west of Scotland and along the shelf edge (depths >200m) in deeper waters. Highest LPUE were observed in the West of Scotland with levels observed 19 to 36kg per hour. Highest discards were also observed here and this pattern was also reflected in the DPUE. The proportion discarded by weight was highest West of Ireland and in the south east where between 90-100% of hake caught were discarded.

Table 3.6 Total Hake Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	GNS VIIbcgjk Dem	49.9	3,018.2	3,068.1	2%	**2%**
	OTB VIIfgjk Dem	1,363.2	1,240.4	2,603.6	52%	**51%**
	SSC VIIgj Dem	433.5	1,728.7	2,162.2	20%	**16%**
	TBB VIIefgh Dem	366.0	242.6	608.6	60%	**14%**
	OTB VIIgfh Neph	416.7	168.8	585.5	71%	**16%**
	OTB VIIj Neph	42.8	7.6	50.4	85%	**2%**
	TOTAL	**2,672.1**	**6,406.3**	**9,078.4**	**29%**	
Irish Sea	OTB VIIa Neph	30.8	99.0	129.8	24%	**94%**
	OTB VIIa Dem*	1.2	31.8	33.0	4%	**4%**
	TBB VIIa Dem*	0.6	10.0	10.6	6%	**2%**
	TOTAL	**32.6**	**140.8**	**173.4**	**19%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	1,779.2	2,078.0	3,857.2	46%	**64%**
	OTB VIIb Neph	717.1	112.8	829.9	86%	**26%**
	OTB VIIbc Dem	250.8	470.6	721.3	35%	**9%**
	OTB VIIck Neph	15.4	119.2	134.5	11%	**1%**
	TOTAL	**2,762.4**	**2,780.6**	**5,542.9**	**50%**	
West of Scotland	OTB VIa Dem	1,048.4	3,122.5	4,170.9	25%	**100%**
	OTB VIa Neph	5.1	12.8	17.8	28%	**0%**
	TOTAL	**1,053.5**	**3,135.3**	**4,188.8**	**25%**	

*Landings values derived from Logbook data

Key Observations for Table

In the Celtic Sea the métier with the highest catch was GNS VIIbcgjk Dem although due to its low discard rate, this métier only contributed to only 2% of discards overall. The OTB VIIfgjk Dem was the predominant métier for discards in the Celtic Sea contributing 51% to overall discards. The West of Ireland had the second highest catch of hake. Within this area, the OTB VIa VIIbcjk Meg & Monk contributed 64% to the overall discards. The West of Scotland was the next most predominant area for hake catches and within this area the OTB VIa Dem accounted for almost 100% of total discards, although the overall discard rate is low relative to other otter trawl fisheries.

Key Observations for Hake Discarding Practices

Discarding is more prominent in fisheries to the West of Ireland with both whitefish and *Nephrops* trawl fisheries recording high discard rates and levels. Improvements in mesh selection are required, particularly in fisheries where mesh size is less than 100mm. Discard reductions could be achieved through increase in mesh size and or the use of square mesh panels.

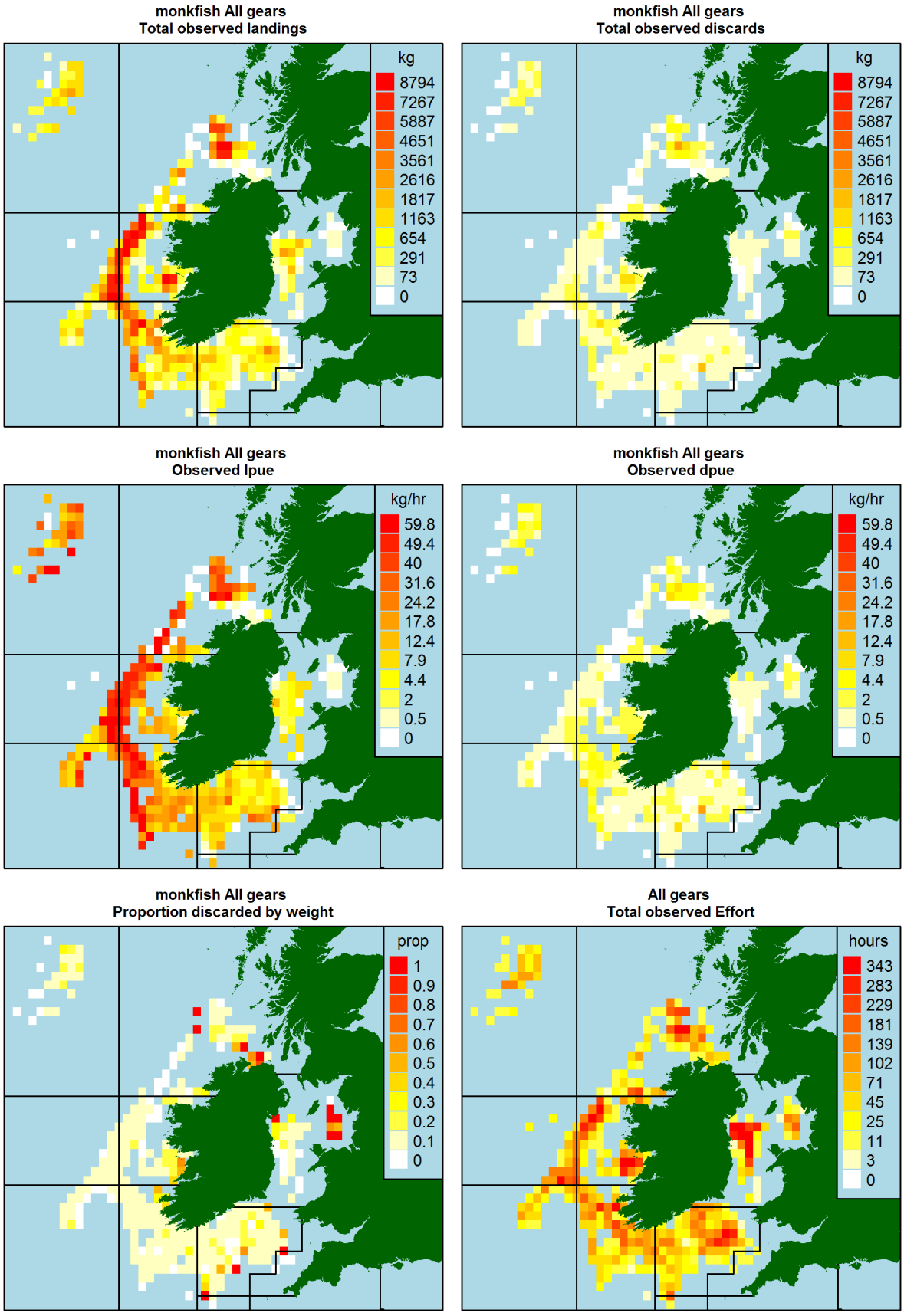


Figure 3.6 **Observed Monkfish Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Monkfish include both species of monk, *Lophius budegasssa* (black-bellied monk) and *Lophius piscatorius* (white-bellied monk). Monkfish were landed widely within the sampled area however there is a distinctive pattern of landings of monkfish all along the shelf edge along the 200m depth contour. Landings were prominent in this area and also on the Porcupine bank and Stanton Bank. The LPUE pattern also reflects the trend in landings with highest LPUE observed along the self edge and south along the 200m contour line. High LPUE was also observed north of Greencastle. Observed LPUE were high, more than 24kg per along the 200m contour. Discarding of monkfish occurred at low levels around the sampled area. Observed DPUE was typically less than 2kg per hour or below. The proportion discarded by weight was generally below 10%.

Table 3.7 Total Monkfish Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	TBB VIIefgh Dem	1,241.2	2,461.0	3,702.2	34%	**73%**
	OTB VIIgfh Neph	205.5	920.7	1,126.2	18%	**12%**
	OTB VIIfgjk Dem	195.4	506.2	701.6	28%	**12%**
	SSC VIIgj Dem	33.0	89.1	122.1	27%	**2%**
	GNS VIIbcgjk Dem	1.9	74.8	76.7	2%	**0%**
	OTB VIIj Neph	16.6		16.6	100%	**1%**
	TOTAL	**1,693.5**	**4,051.8**	**5,745.3**	**29%**	
Irish Sea	OTB VIIa Neph	27.2	337.0	364.2	7%	**36%**
	TBB VIIa Dem	4.8	347.2	351.9	1%	**6%**
	SSC VIIa Dem	22.8	4.4	27.1	84%	**30%**
	OTB VIIa Dem*	20.7	226.6	247.3	8%	**27%**
	TOTAL	**75.4**	**915.2**	**990.7**	**8%**	
Rockall	OTB VIb Dem	32.0	558.7	590.7	5%	**100%**
	TOTAL	**32.0**	**558.7**	**590.7**	**5%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	626.7	5,519.0	6,145.7	10%	**81%**
	OTB VIIck Neph	12.7	447.6	460.3	3%	**2%**
	OTB VIIb Neph	79.5	360.4	439.9	18%	**10%**
	OTB VIIbc Dem	56.9	47.1	103.9	55%	**7%**
	TOTAL	**775.7**	**6,374.1**	**7,149.8**	**11%**	
West of Scotland	OTB VIa Dem	178.0	602.9	780.8	23%	**99%**
	OTB VIa Neph	1.8		1.8	100%	**1%**
	TOTAL	**179.8**	**602.9**	**782.6**	**23%**	

*Landings values derived from Logbook data

Key Observations for Table

The two main areas for monkfish catches were the West of Ireland and Celtic Sea. Within the West of Ireland, the OTB VIa VIIbcjk Meg & Monk métier had the highest landings and catches of monkfish and overall the level of discards is low. In the Celtic Sea the métier with the highest observed catches was the TBB VIIefgh Dem métier which discarded 29% of the catch and made the highest contribution to discarding levels in the Celtic sea (73%).

Key Observations for Monkfish Discarding Practices

Due to the physical shape of monkfish, adjustments in mesh size and/or shape offer little in the way of improving size selectivity. While the TBB VIIefgh métier has a high contribution to overall discarding it should be noted that effort in this métier has declined by about 30% since 2006.

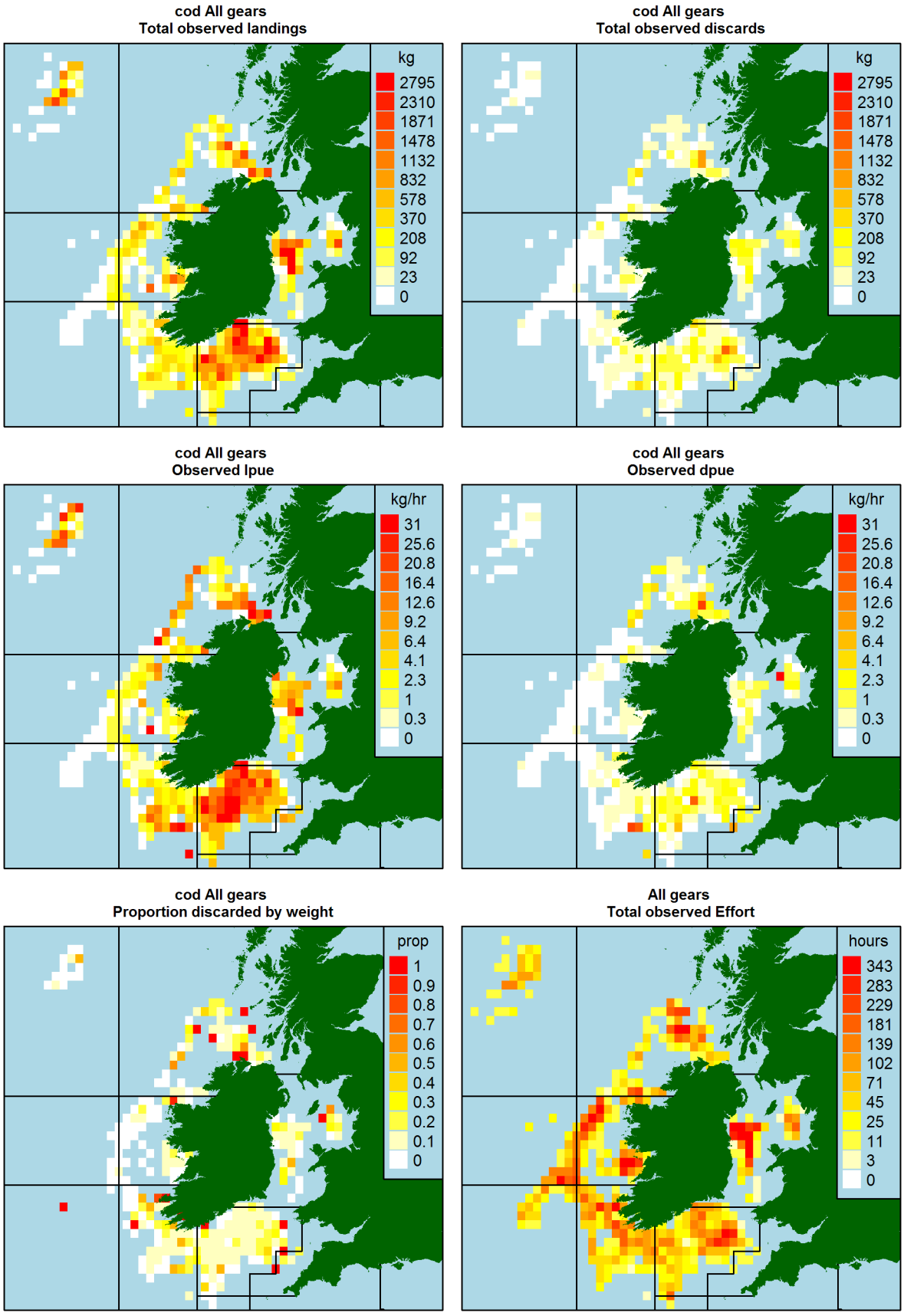


Figure 3.7 **Observed Cod Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

The majority of cod landings are associated with the Celtic Sea cod stock. Other notable areas include the Western Irish Sea (VIIa) and the Northern Coast (VIa). Landings of cod in the west coast and south coast were generally low. The LPUE plots show a similar pattern. LPUE highest in the Celtic Sea. There is a high LPUE associated with VIa, localised spots in the Cape Grounds and in western Irish sea.
Total observed discards of cod and DPUE are very low in all areas, typically less than 2.3kg per hr. There were almost no discards observed along the west coast close to the Shelf edge. The proportion of cod discarded by weight is very low in all areas. There are a few pixels with higher discard rates but these reflect variability in the data rather than areas with higher discarding.

Table 3.8 Total Cod Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	OTB VIIfgjk Dem	273.9	2,522.8	2,796.6	10%	**30%**
	OTB VIIgfh Neph	204.1	1,466.8	1,670.9	12%	**22%**
	SSC VIIgj Dem	351.3	1,151.7	1,503.0	23%	**38%**
	GNS VIIbcgjk Dem	1.8	1,441.5	1,443.4	0%	**0%**
	TBB VIIefgh Dem	80.1	726.0	806.1	10%	**9%**
	OTB VIIj Neph	6.9	0.3	7.1	96%	**1%**
	TOTAL	**918.0**	**7,309.1**	**8,227.1**	**11%**	
Irish Sea	OTB VIIa Neph	37.6	487.0	524.6	7%	**58%**
	OTB VIIa Dem*	0	418.5	418.5	0%	**0%**
	TBB VIIa Dem	27.4	106.9	134.3	20%	**42%**
	TOTAL	**65.0**	**1012.4**	**1077.4**	**6%**	
Rockall	OTB VIb Dem	0.1	259.5	259.6	0%	**100%**
	TOTAL	**0.1**	**259.5**	**259.6**	**0%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	88.5	247.1	335.6	26%	**98%**
	OTB VIIbc Dem	0.1	32.6	32.7	0%	**0%**
	OTB VIIb Neph	2.0	15.1	17.1	11%	**2%**
	OTB VIIck Neph	0.2		0.2	100%	**0%**
	TOTAL	**90.7**	**294.8**	**385.5**	**24%**	
West of Scotland	OTB VIa Dem	65.7	389.6	455.3	14%	**100%**
	OTB VIa Neph	0.3	1.1	1.4	21%	**0%**
	TOTAL	**66.0**	**390.6**	**456.6**	**14%**	

*Landings values derived from Logbook data

Key Observations for Table

The Celtic sea was the predominant area for cod catches. Within the Celtic Sea there were three main métiers: OTB VIIfgjk Dem, OTB VIIgfh Neph and SSC VIIgj Dem that accounted for the majority of cod discards, contributing 30%, 22% and 38%, respectively. This confirms the patterns observed in the maps. The discard rate observed for the Celtic sea seine net métier (SSC VIIgj Dem) was relatively high at 23%, however its overall contribution to discards in the Celtic Sea is similar to the OTB VIIfgjk dem and the VIIfg Neph métiers. Discard levels in other métiers and areas vary although total catches were generally low. In the Irish Sea, TBB VIIa Dem has a high discard rate (20%), however due to the low landings of cod in this métier the overall contribution to discarding is similar to that of the VIIa Neph métier.

Key Observations for Cod Discarding Practices

Based on international data, Irish cod catches (landings and discards) in areas such as the West of Scotland and the Irish Sea, are low relative to other nationalities (ICES, 2011). The proportion discarded was generally below 10%.
While the data for 2003-2009, shows very little discarding for cod, the data in 2010 indicates higher levels of discarding associated with strong recruitment into the fishery. Due to the low stock status of cod in VIa and VIIa, cod catches should be reduced as far as practically possible through the use of more selective gears such as the Swedish grid or through other cod avoidance measures e.g. closed areas. In some instances cod discards may be associated with restrictive quotas.

PLAICE

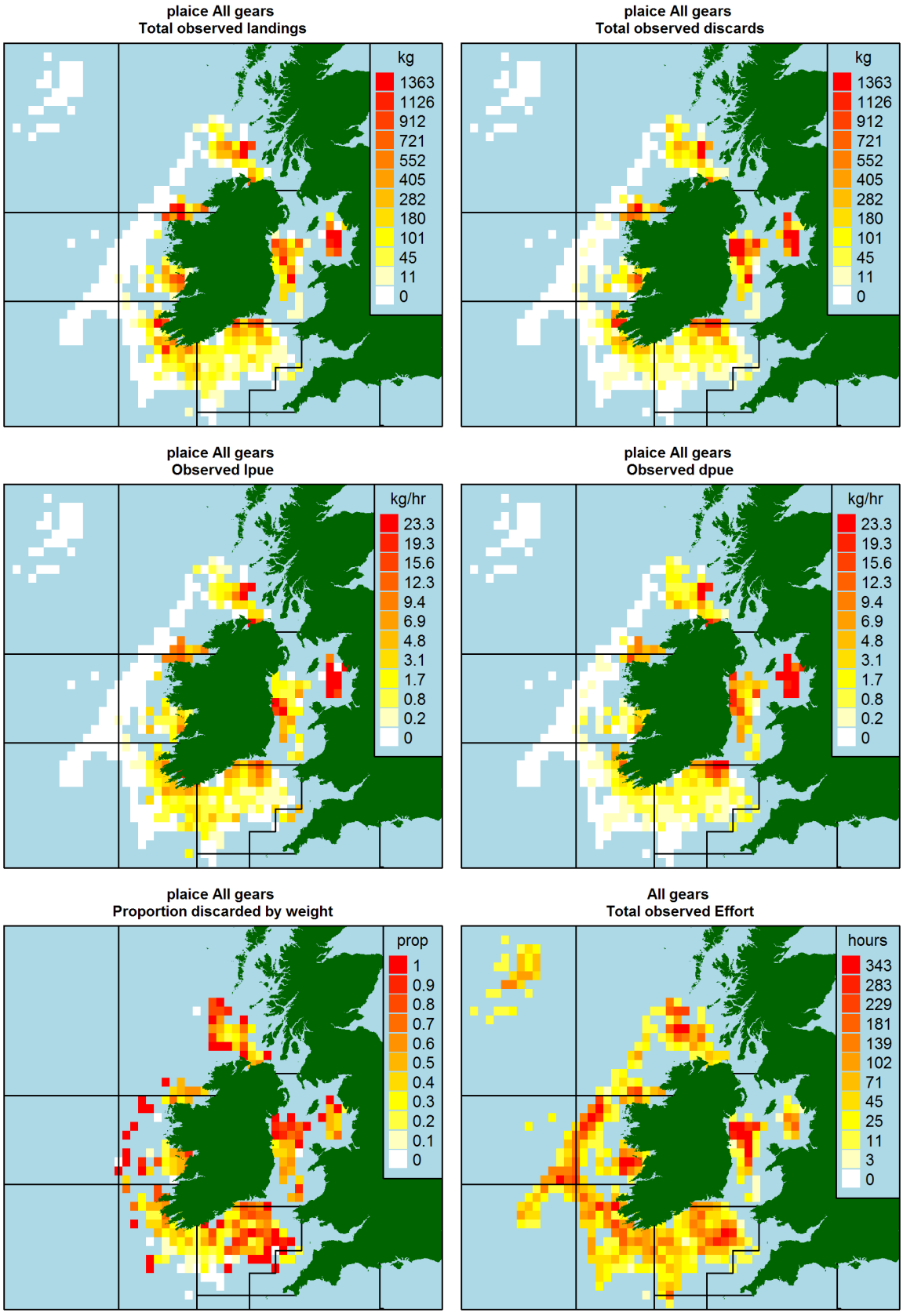


Figure 3.8 **Observed Plaice Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Plaice landings were predominantly observed in coastal areas. Highest observed landings were in the Irish Sea, in VIa off the Stag grounds and Galway Bay. LPUE patterns follow the same trends observed in the landings. Plaice is one of the most commonly discarded commercial species and discard rates across all fisheries are high. Areas of high discarding also coincided with areas of high landings, the Irish Sea, off the Stags in VIa and near the south east coast. Highest DPUE values were observed in the Eastern Irish Sea, in Morecambe Bay and Whitehaven Bay. The proportion discarded by weight was generally greater than 60%.

Table 3.9 Total Plaice Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	OTB VIIfgjk Dem	1,683.9	1,031.9	2,715.8	62%	**41%**
	TBB VIIefgh Dem	2,117.9	184.7	2,302.6	92%	**52%**
	SSC VIIgj Dem	101.3	147.8	249.1	41%	**2%**
	OTB VIIgfh Neph	123.6	114.6	238.2	52%	**3%**
	OTB VIIj Neph	64.1	26.7	90.8	71%	**2%**
	GNS VIIbcgjk Dem	0.2	0.3	0.6	41%	**0%**
	TOTAL	**4,090.9**	**1,506.1**	**5,597.0**	**73%**	
Irish Sea	OTB VIIa Neph	2,171.3	310.4	2,481.8	87%	**72%**
	OTB VIIa Dem*	510.8	332.6	843.4	61%	**17%**
	TBB VIIa Dem	231.0	262.0	493.0	47%	**8%**
	SSC VIIa Dem	83.8	79.5	163.3	51%	**3%**
	TOTAL	**2,997.0**	**984.5**	**3,981.4**	**75%**	
West of Ireland	OTB VIIbc Dem	774.7	264.3	1,039.0	75%	**53%**
	OTB VIa VIIbcjk Meg & Monk	575.1	317.7	892.7	64%	**40%**
	OTB VIIb Neph	100.2	21.0	121.2	83%	**7%**
	TOTAL	**1,449.9**	**603.0**	**2,053.0**	**71%**	
West of Scotland	OTB VIa Dem	1,368.5	1,212.1	2,580.6	53%	**100%**
	OTB VIa Neph	5.7	0.1	5.9	98%	**0%**
	TOTAL	**1,374.3**	**1,212.2**	**2,586.5**	**53%**	

*Landings values derived from Logbook data

Key Observations for Table

All areas had relatively high levels of plaice catches. The Celtic Sea however had the highest catches overall. Within this area the OTB VIIfgjk Dem and TBB VIIefgh Dem métiers contributed to the majority of the discards with 41% and 52%, respectively. In the Irish Sea, the most predominant métier for plaice catches and discards was the OTB VIIa Neph métier contributing 72% to overall discards levels in the area. There were two dominant métiers in the West of Ireland, the OTB VIIbc Dem and OTB VIa VIIbcjk Meg & Monk. These accounted for 93% of total discards in that area. In the West of Scotland, the OTB VIa Dem contributed almost 100% to the overall discards.

Key Observations for Plaice Discarding Practices

Plaice discarding is associated with métiers using mesh sizes less than 100mm. There is a need to reduce discarding of plaice given the high levels of discarding across all métiers. Increasing mesh size in the smaller mesh fisheries would result in losses of the target species in the TBB VIIefgh and the VIIa Neph métiers. For the VIIa Neph métier, inclusion of a sorting grid has demonstrated significant reductions in plaice (see Chapter 4). Reducing plaice discards in the TBB VIIefgh métier is more problematic as it would result in losses of black sole.

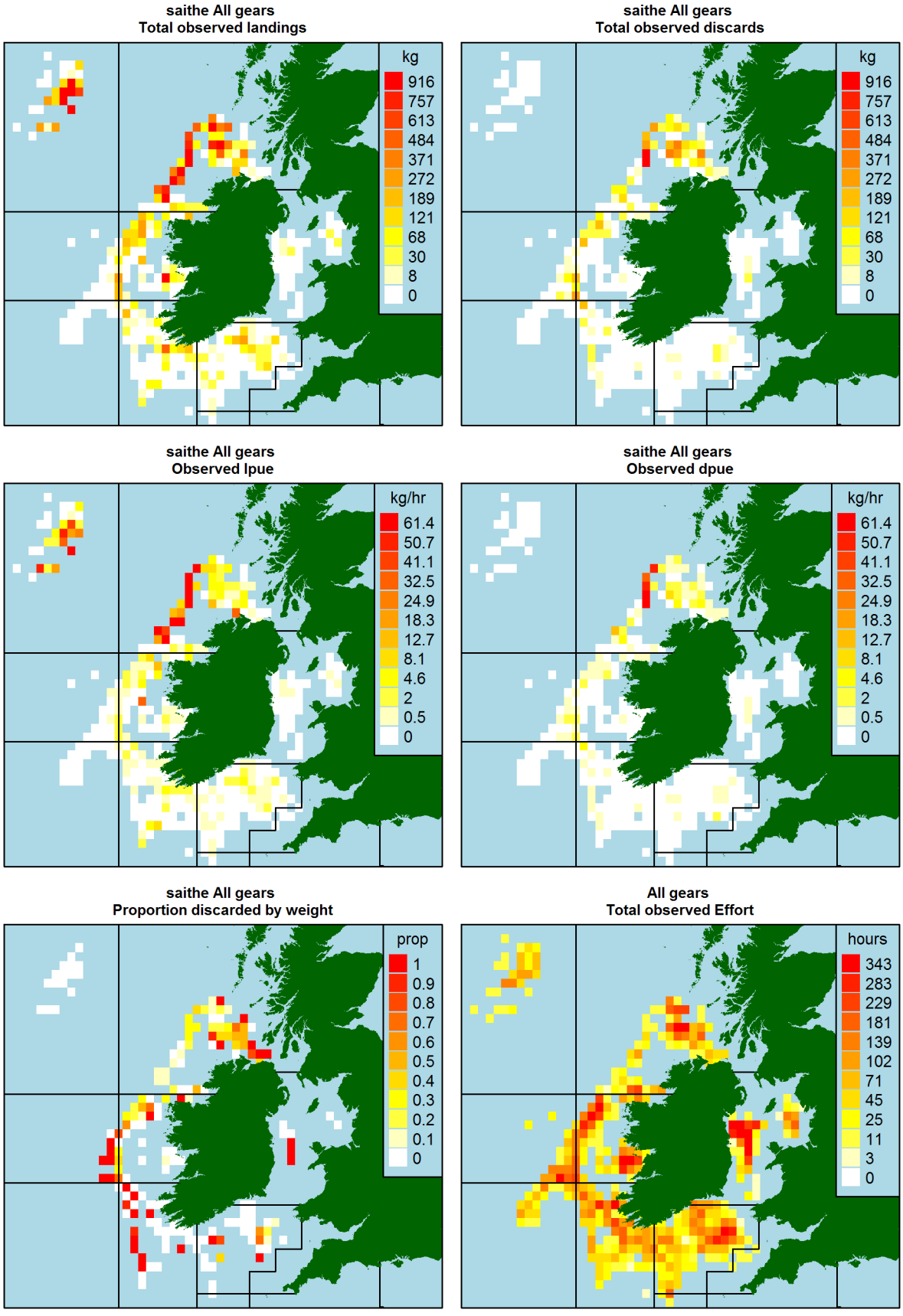


Figure 3.9 **Observed Saithe Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

In general saithe landings are low and largely confined to VIa, along the 200m depth counter and in Rockall. Sparse landings were observed elsewhere. The LPUE pattern follows the same pattern as the landings. LPUE values vary with highest LPUE values of between 24.9 and 61.4kg per hour being observed in VIa. Overall, discard rates are low, with highest observed discards and DPUE observed in VIa along the 200m contour. The proportion discarded by weight was variable, reflecting variability in the data or areas where there were marginally higher discard than there were landings.

Table 3.10 Total Saithe Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	GNS VIIbcgjk Dem		95.4	95.4	0%	**0%**
	TBB VIIefgh Dem		49.5	49.5	0%	**0%**
	OTB VIIfgjk Dem	1.2	24.2	25.4	5%	**54%**
	OTB VIIgfh Neph		8.9	8.9	0%	**0%**
	SSC VIIgj Dem	1.0		1.0	100%	**46%**
	TOTAL	**2.2**	**178.0**	**180.3**	**1%**	
Irish Sea	TBB VIIa Dem*	1.3	3.0	4.3	30%	**100%**
	OTB VIIa Dem*		17.3	17.3	0%	**0%**
	OTB VIIa Neph		1.0	1.0	0%	**0%**
	TOTAL	**1.3**	**21.3**	**22.6**	**58%**	
Rockall	OTB VIb Dem		567.7	567.7	0%	
	TOTAL		**567.7**	**567.7**	**0%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	111.8	353.6	465.4	24%	**99%**
	OTB VIIbc Dem		209.4	209.4	0%	**0%**
	OTB VIIck Neph	0.8		0.8	100%	**1%**
	OTB VIIb Neph	0.2	0.1	0.2	77%	**0%**
	TOTAL	**112.8**	**563.0**	**675.8**	**17%**	
West of Scotland	OTB VIa Dem	351.4	1,649.0	2,000.4	18%	**100%**
	OTB VIa Neph	0.2	3.8	4.0	4%	**0%**
	TOTAL	**351.5**	**1,652.8**	**2,004.3**	**18%**	

*Landings values derived from Logbook data

Key Observations for Table

There was one main métier which dominated the saithe catches across all of the areas sampled, the OTB VIa Dem métier in West of Scotland. This is mainly due to the high landings observed. This métier also had the highest discard level amongst all other métiers (351 tonnes). Discard levels in all other métiers and areas were comparably low.

Key Observations for Saithe Discarding Practices

Saithe discards in general are low in Irish fisheries.

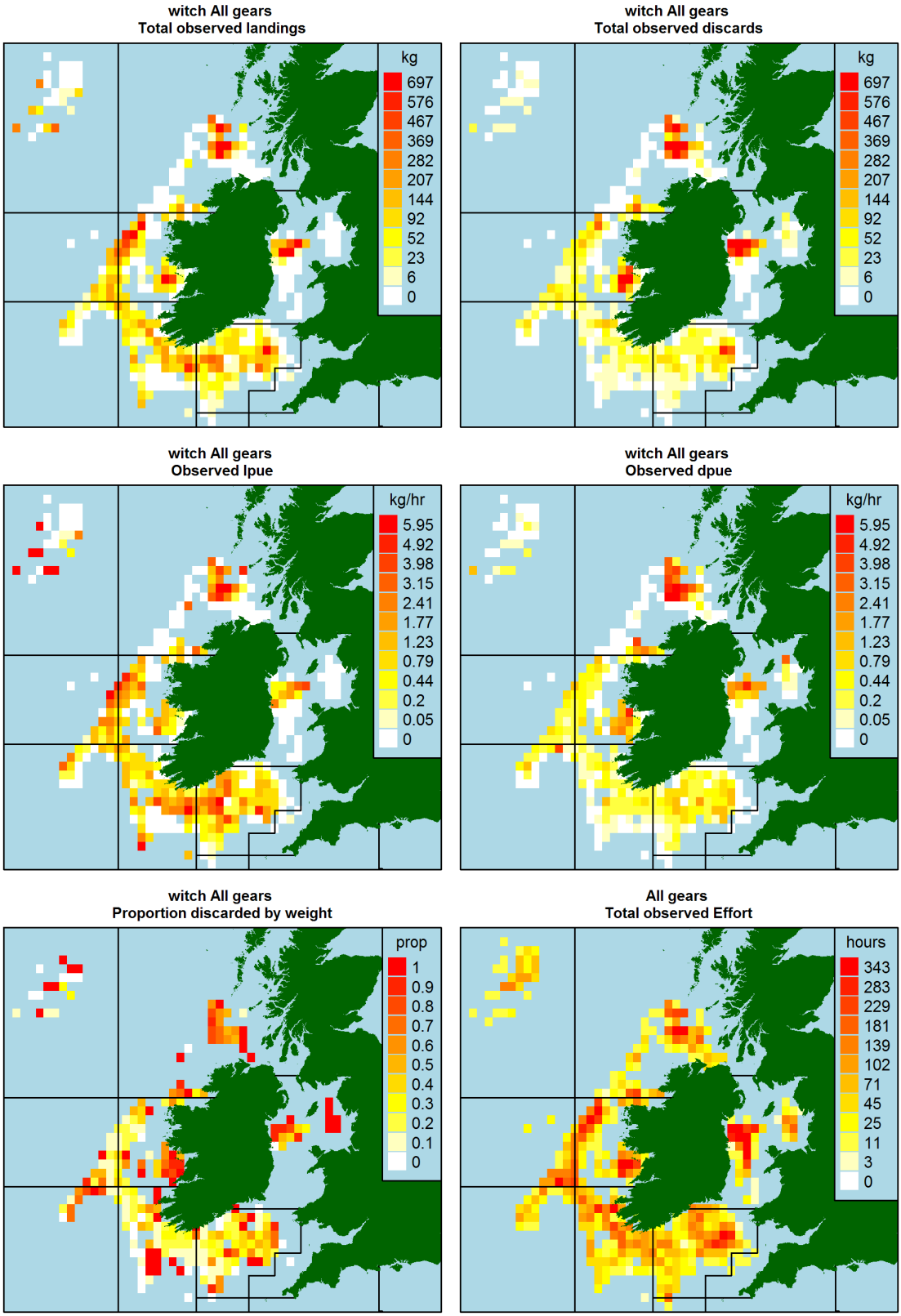


Figure 3.10 **Observed Witch Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Highest landings of witch were observed in VIa and VIIb along the shelf edge and VIIa. Similar patterns are reflected in the LPUE data. Highest discards were observed in VIa and VIIa. Highest DPUE values were observed in VIa. The proportion discarded by weight is quite high in most areas.

Table 3.11 Total Witch Catch in tonnes by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	Discard rate	% Contribution
Celtic Sea	TBB VIIefgh Dem	238.8	630.1	868.9	27%	**43%**
	OTB VIIgfh Neph	189.7	361.8	551.5	34%	**34%**
	OTB VIIfgjk Dem	107.9	183.2	291.1	37%	**19%**
	SSC VIIgj Dem	12.1	80.9	93.0	13%	**2%**
	OTB VIIj Neph	6.9	9.2	16.0	43%	**1%**
	GNS VIIbcgjk Dem		1.3	1.3	0%	**0%**
	TOTAL	**555.3**	**1,266.5**	**1,821.8**	**30%**	
Irish Sea	OTB VIIa Neph	402.3	131.9	534.2	75%	**99%**
	SSC VIIa Dem	1.9	20.5	22.4	8%	**0%**
	OTB VIIa Dem*	0.6	33.6	34.2	2%	**0%**
	TBB VIIa Dem*		28.5	28.5	0%	**0%**
	TOTAL	**404.8**	**214.5**	**619.3**	**65%**	
Rockall	OTB VIb Dem	0.4	41.0	41.4	1%	**100%**
	TOTAL	**0.4**	**41.0**	**41.4**	**1%**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	629.3	620.6	1,250.0	50%	**58%**
	OTB VIIb Neph	355.3	97.5	452.8	78%	**33%**
	OTB VIIbc Dem	81.1		81.1	100%	**7%**
	OTB VIIck Neph	17.6	36.4	54.0	33%	**2%**
	TOTAL	**1,083.3**	**754.5**	**1,837.8**	**59%**	
West of Scotland	OTB VIa Dem	230.8	55.3	286.2	81%	**98%**
	OTB VIa Neph	3.7	1.2	4.8	76%	**2%**
	TOTAL	**234.5**	**56.5**	**291.0**	**81%**	

*Landings values derived from Logbook data

Key Observations for Table

The West of Ireland had the highest catches of witch. There are two main métiers, OTB VIa VIIbcjk Meg & Monk and OTB VIIb Neph which made the biggest contribution to overall discards. Both these métiers had high discard rates relatively to their catches, 50% and 78% respectively. The Celtic Sea had the second highest observed catches of witch. There were three main métiers which contributed to the majority of the discarding, TBB VIIefgh Dem, OTB VIIgfh Neph and OTB VIIfgjk Dem. These three métiers accounted for 96% of the total discards within that area. In the Irish Sea the OTB VIIa Neph métier contributed to 99% of the overall discarding.

Key Observations for Witch Discarding Practices

Witch discards vary between métier and area. The west of Ireland had the highest discard level overall.

NEPHROPS

Discarding patterns for Irish *Nephrops* vessels have been routinely monitored mainly through self-sampling of catches, where the industry provide the samples, from the main fishing grounds for several years. Discard rates are generally around 22% by weight and 34% by number for the main fishing grounds (FU15, FU17 and FU22). These grounds are typically characterised by high densities of smaller *Nephrops*. Discarding is mainly limited to smaller or damaged individuals. Discard rates are highly variable, mainly driven by market demand for smaller *Nephrops* and sometimes by variable recruitment strength.

Discard estimates for other *Nephrops* grounds are more sparse. The sampling does indicate discard rates to be quite low on the Porcupine Bank (FU16), SW and SE Ireland (FU 19) and on the Labadie Bank (FU20 & 21). These grounds typically have lower densities of larger *Nephrops* and catch rates of smaller individuals are normally lower.

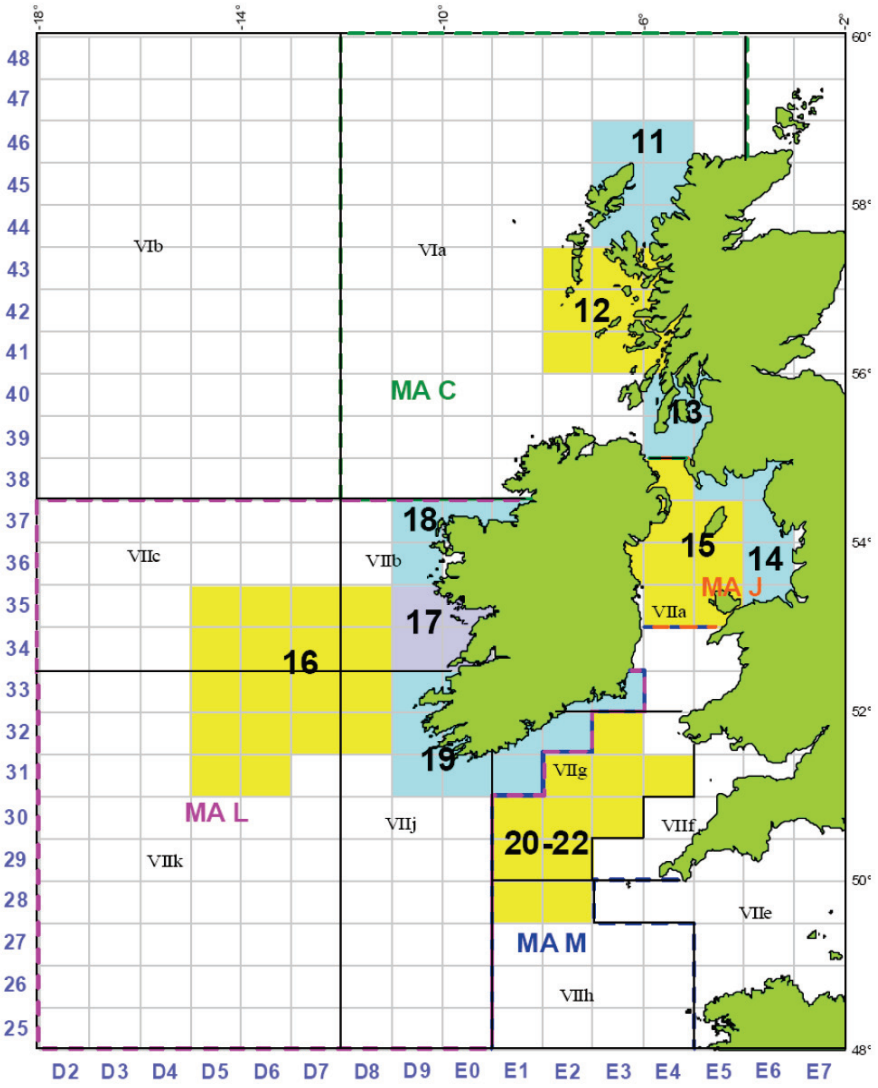


Figure 3.11 ***Nephrops*** **Functional Units (FUs) and Management Areas (MAs) around Ireland.**

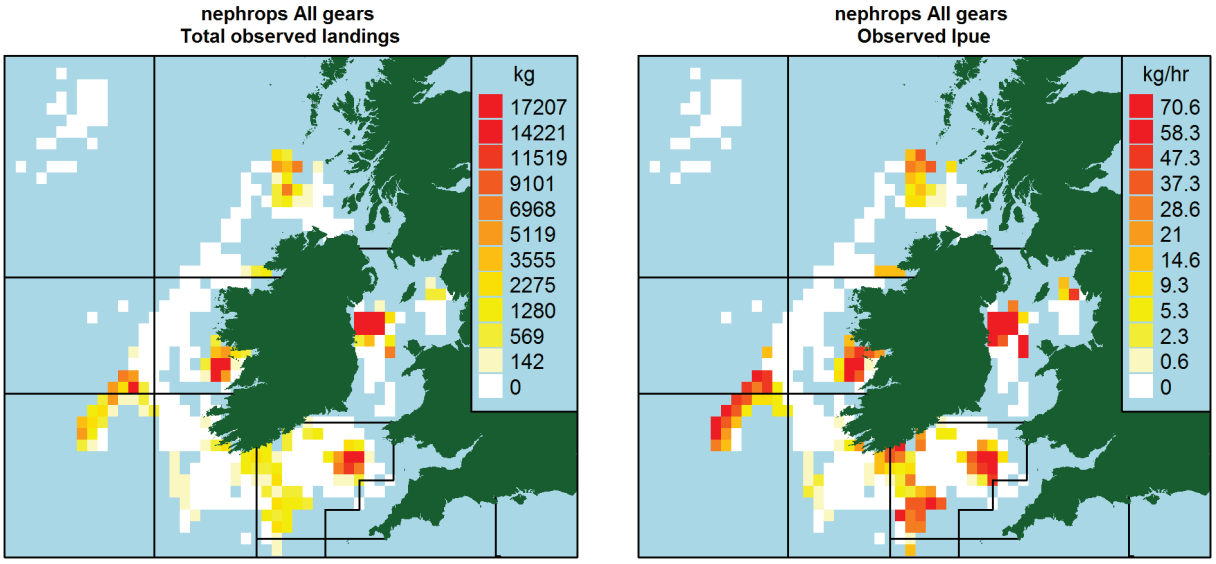


Figure 3.12 Observed *Nephrops* Landings and effort from Discard Sampling Trips carried out between 1995-2009.

Figure 3.12 shows the *Nephrops* landings as observed from discard sampling trips carried out between 1995-2009. Landings are predominately observed in the main fishing grounds of the Irish Sea, Celtic Sea, Aran grounds, but also the Porcupine and VIa, in Stanton Bank and Donegal Bay. LPUE trends follow the same pattern as the landings.

Table 3.12 Summary of Irish *Nephrops* landings and discards in weight and number for the main *Nephrops* fishing grounds from 2003-2009.

Functional Unit/Grounds	Year	Landings Weight (tonnes)	Discard Weight (tonnes)	% by Weight	Landings Numbers (millions)	Discards Numbers (millions)	% by number
FU15 / Western Irish Sea *Nephrops*	2003	2,694	1,016	27%	154	111	42%
	2004	2,776	761	22%	159	83	34%
	2005	2,100	454	18%	111	51	31%
	2006	2,027	615	23%	126	70	36%
	2007	2,745	1,058	28%	166	122	42%
	2008	3,132	420	12%	163	44	21%
	2009	2,343	763	25%	122	83	41%
FU17 / Aran Grounds *Nephrops*	2003	925	187	17%	44	18	29%
	2004	525	116	18%	29	11	28%
	2005	764	192	20%	42	20	33%
	2006						
	2007			*No Sampling*			
	2008	1,050	258	20%	47	22	32%
	2009	625	264	30%	24	16	40%
FU22 / Celtic Sea *Nephrops* (Smalls)	2003	1,390	363	21%	65	37	36%
	2004	1,599	104	6%	63	7	11%
	2005	2,364	1,120	32%	112	89	44%
	2006	1,838	607	25%	102	57	36%
	2007	3,178	1,641	34%	182	165	48%
	2008	3,384	806	19%	143	66	31%
	2009	2,825	448	14%	117	39	25%

Source: Self-sampling discard estimates raised using total reported landings from Irish Logbook database
Nephrops landings are estimated for the main fishing grounds only (FU15, 17 and 22) these account for ~80% of the total landings.

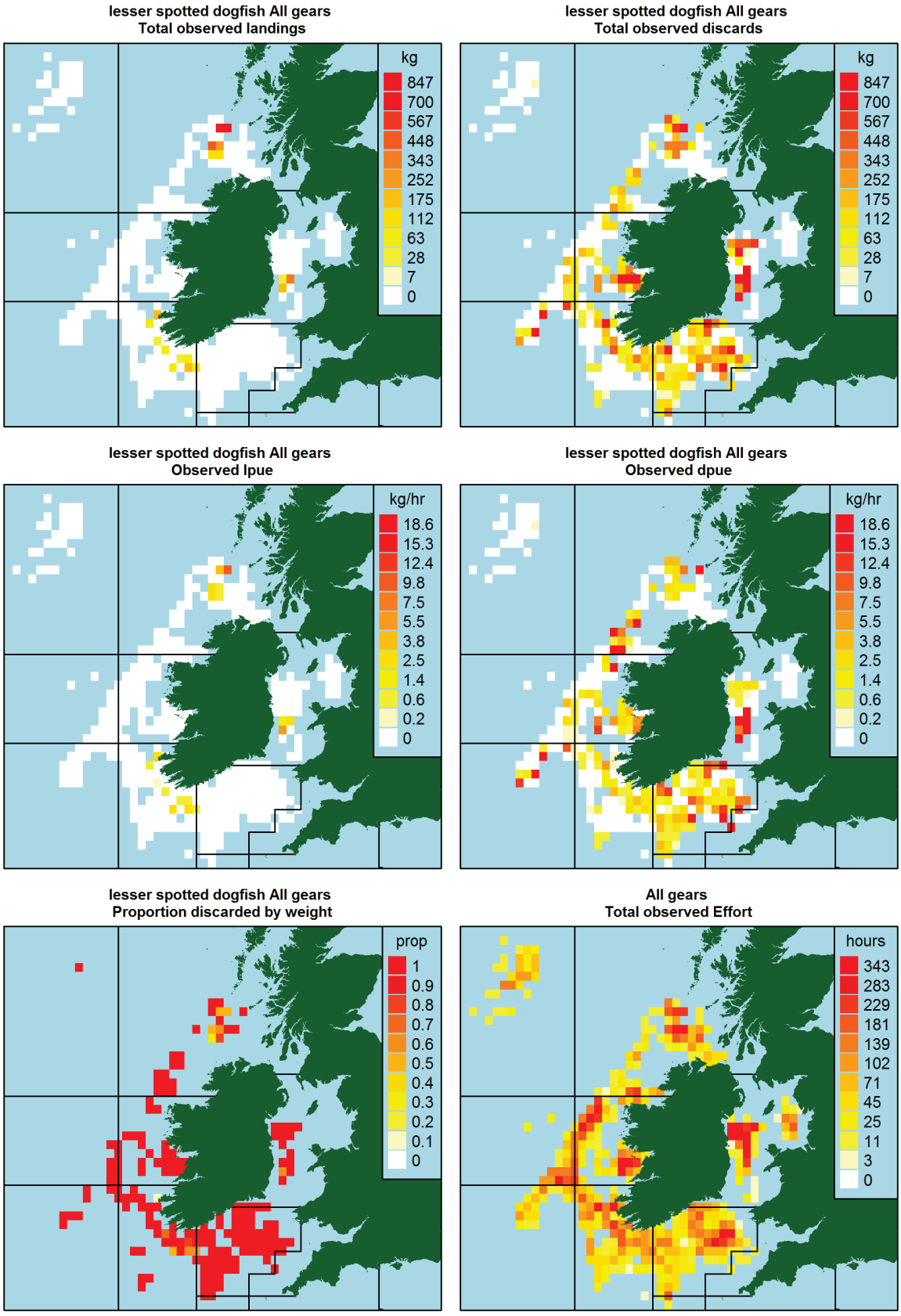


Figure 3.13 **Observed Lesser Spotted Dogfish Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Marginal landings of lesser spotted dogfish have been observed in VIa, VIIa and VIIj. Generally discarding of this species occurs across all areas. DPUE levels are low and vary between 0-18 kg per hour. With the exception of a few areas in VIa and VIIj, all lesser spotted dogfish caught have been discarded.

Table 3.13 Total Lesser Spotted Dogfish Catch by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	% Contribution
Celtic Sea	TBB VIIefgh Dem	3,476.2		3,476.2	**69%**
	OTB VIIfgjk Dem	735.1	1.0	736.1	**15%**
	OTB VIIgfh Neph	518.5		518.5	**10%**
	GNS VIIbcgjk Dem	225.3		225.3	**4%**
	SSC VIIgj Dem	84.6		84.6	**2%**
	OTB VIIj Neph	6.3	2.2	8.4	**0%**
	TOTAL	**5,045.9**	**3.2**	**5,049.0**	
Irish Sea	TBB VIIa Dem	1,794.6		1,794.6	**58%**
	OTB VIIa Neph	968.4		968.4	**31%**
	SSC VIIa Dem	322.4		322.4	**10%**
	TOTAL	**3,085.4**		**3,085.4**	
Rockall	OTB VIb Dem	0.7		0.7	**100%**
	TOTAL	**0.7**		**0.7**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	2,188.1	13.5	2,201.6	**52%**
	OTB VIIbc Dem	1,414.3		1,414.3	**33%**
	OTB VIIb Neph	625.1		625.1	**15%**
	TOTAL	**4,227.5**	**13.5**	**4,241.0**	
West of Scotland	OTB VIa Dem	487.0		487.0	**100%**
	TOTAL	**487.0**		**487.0**	

Key Observations for Table

In the Celtic Sea and the Irish Sea, there were two predominant métiers for lesser spotted dogfish discards, TBB VIIefgh Dem and TBB VIIa Dem, accounting for 69% and 58% of the total discards, respectively. In the West of Ireland, there were two main métiers, OTB VIa VIIbcjk Meg & Monk and OTB VIIbc Dem which combined accounted for 85% of the total discards in that area.

Key Observations for Lesser Spotted Dogfish Discarding Practices

Discards of this species were observed to occur in all of the sampled areas. Some landings of lesser spotted dogfish are typically used as bait for pot fisheries for crab and lobster.

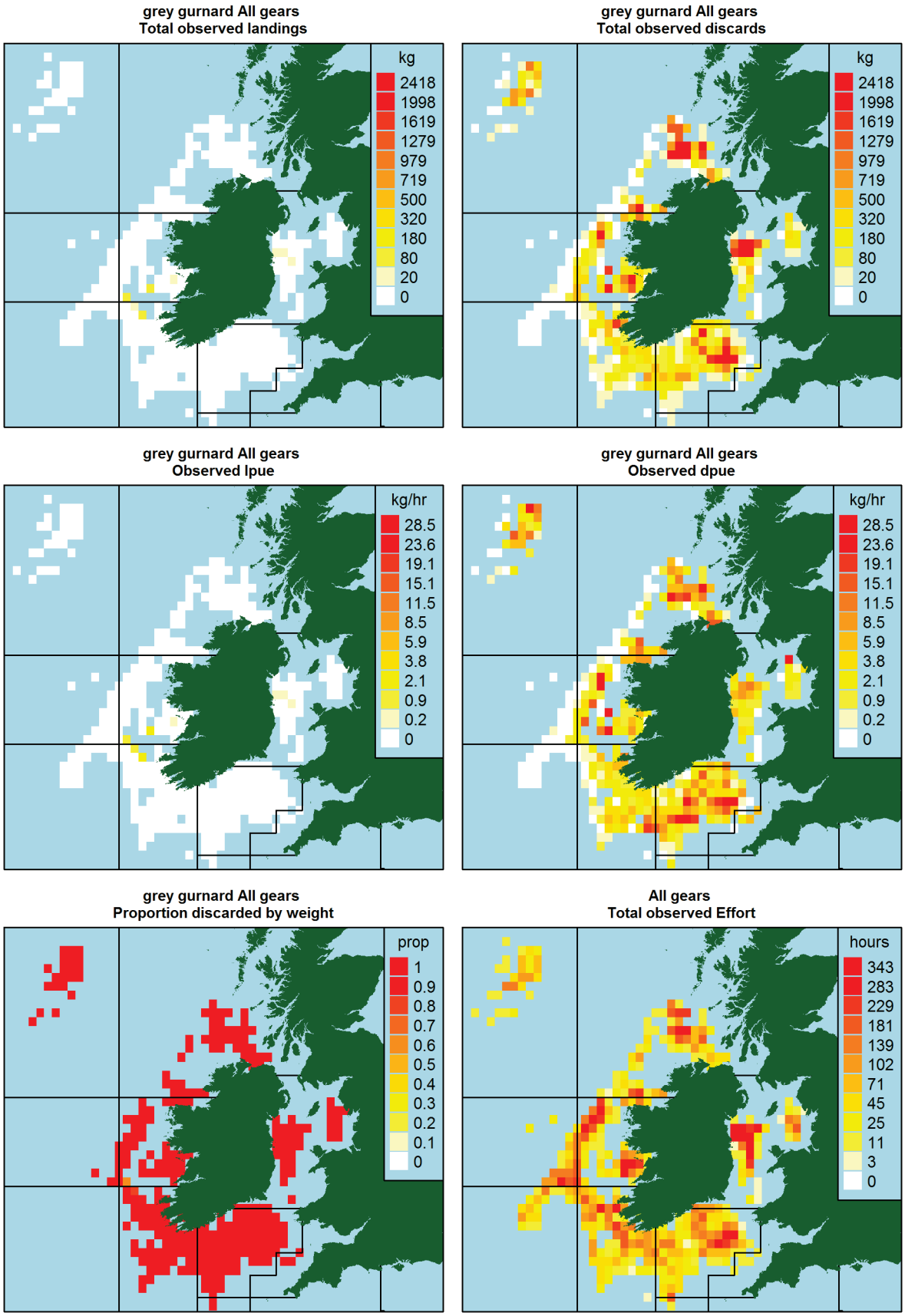


Figure 3.14 **Observed Grey Gurnard Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Very little landings of grey gurnard were observed for most of the sampled areas. Discards were observed in the western Irish Sea, Celtic sea and Stanton. Discard DPUE values on average vary from between 2 and 9 kg per hour, highest values of 28 kg per hour have been observed. The highest DPUE is observed in the Celtic Sea and VIa. Almost 100% of grey gurnard caught are discarded.

Table 3.14 Total Grey Gurnard Catch by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	% Contribution
Celtic Sea	OTB VIIfgjk Dem	1,832.7		1,832.7	**42%**
	OTB VIIgfh Neph	925.1		925.1	**21%**
	TBB VIIefgh Dem	813.6		813.6	**18%**
	SSC VIIgj Dem	751.0		751.0	**17%**
	OTB VIIj Neph	73.7		73.7	**2%**
	GNS VIIbcgjk Dem	5.5		5.5	**0%**
	TOTAL	**4,401.5**		**4,401.5**	
Irish Sea	OTB VIIa Neph	2,810.5	2.2	2,812.7	**93%**
	OTB VIIa Dem	95.3		95.3	**3%**
	TBB VIIa Dem	83.9		83.9	**3%**
	SSC VIIa Dem	20.0		20.0	**1%**
	TOTAL	**3,009.8**	**2.2**	**3,012.0**	
Rockall	OTB VIb Dem	161.1		161.1	**100%**
	TOTAL	**161.1**		**161.1**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	1,909.3		1,909.3	**60%**
	OTB VIIbc Dem	721.2		721.2	**23%**
	OTB VIIb Neph	534.0	0.1	534.1	**17%**
	TOTAL	**3,164.5**	**0.1**	**3,164.6**	
West of Scotland	OTB VIa Dem	1,458.6		1,458.6	**99%**
	OTB VIa Neph	13.6		13.6	**1%**
	TOTAL	**1,472.2**		**1,472.2**	**42%**

Key Observations for Table

Highest discards of grey gurnard were observed in the OTB VIIa Neph, OTB VIIfgjk Dem, OTB VIa VIIbcjk Meg & Monk and OTB VIa Dem métiers, spanning the Celtic Sea, Irish Sea, West of Ireland and West of Scotland.

Key Observations for Grey Gurnard Discarding Practices

There is no commercial market for grey gurnard although they are sometimes landed for bait. There is no quota for this species.

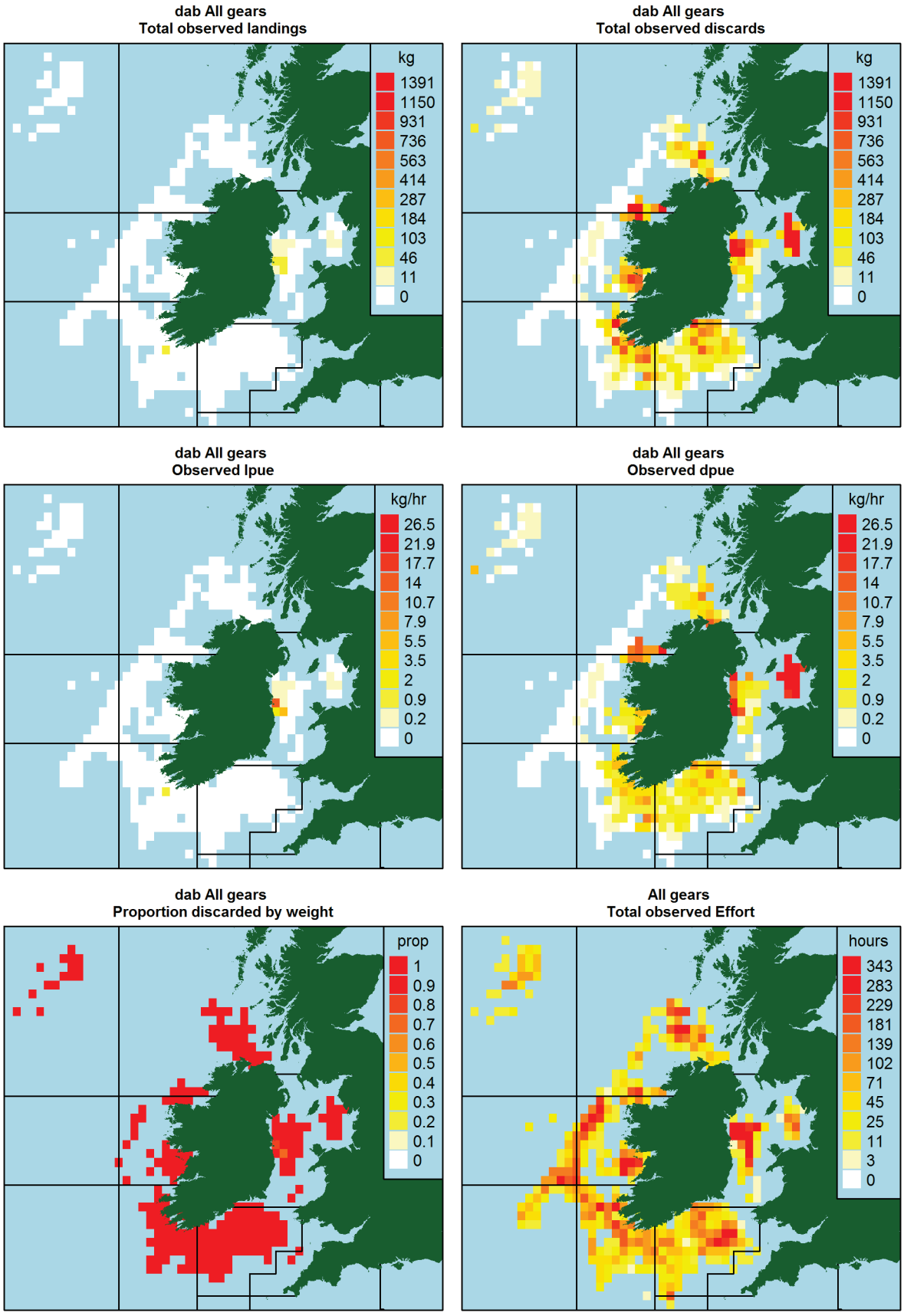


Figure 3.15 **Observed Dab Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Very few landings of dab have been observed, these have occurred predominantly in the Irish sea. Observed discards have been limited to less than 200m and are more prominent in coastal areas. Highest discards and DPUE values were observed in the eastern Irish Sea, with values greater than 21kg per hour. Average values ranged from 0-3kg per hour.

Table 3.15 Total Dab Catch by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	% Contribution
Celtic Sea	OTB VIIfgjk Dem	938.7		938.7	**69%**
	OTB VIIgfh Neph	129.4		129.4	**10%**
	SSC VIIgj Dem	128.4		128.4	**9%**
	OTB VIIj Neph	126.9		126.9	**9%**
	TBB VIIefgh Dem	28.7		28.7	**2%**
	GNS VIIbcgjk Dem	0.2		0.2	**0%**
	TOTAL	**1,352.1**		**1,352.1**	
Irish Sea	OTB VIIa Neph	1,981.2	2.0	1,983.2	**88%**
	OTB VIIa Dem	247.9		247.9	**11%**
	TBB VIIa Dem	16.1		16.1	**1%**
	SSC VIIa Dem	1.3		1.3	**0%**
	TOTAL	**2,246.4**	**2.0**	**2,248.5**	
Rockall	OTB VIb Dem	0.5		0.5	**100%**
	TOTAL	**0.5**		**0.5**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	969.3		969.3	**65%**
	OTB VIIbc Dem	365.0		365.0	**24%**
	OTB VIIb Neph	164.0		164.0	**11%**
	TOTAL	**1,498.3**		**1,498.3**	
West of Scotland	OTB VIa Dem	782.7		782.7	**90%**
	OTB VIa Neph	91.1		91.1	**10%**
	TOTAL	**873.8**		**873.8**	

Key Observations for Table

Highest discards were observed in the OTB VIIa Neph métier. This métier accounted for 88% of the overall discards in the Irish Sea.

Key Observations for Dab Discarding Practices

Discarding of dab is generally associated with otter trawls using smaller meshes. Any improvements in mesh size selectivity will help to reduce discarding of dab.

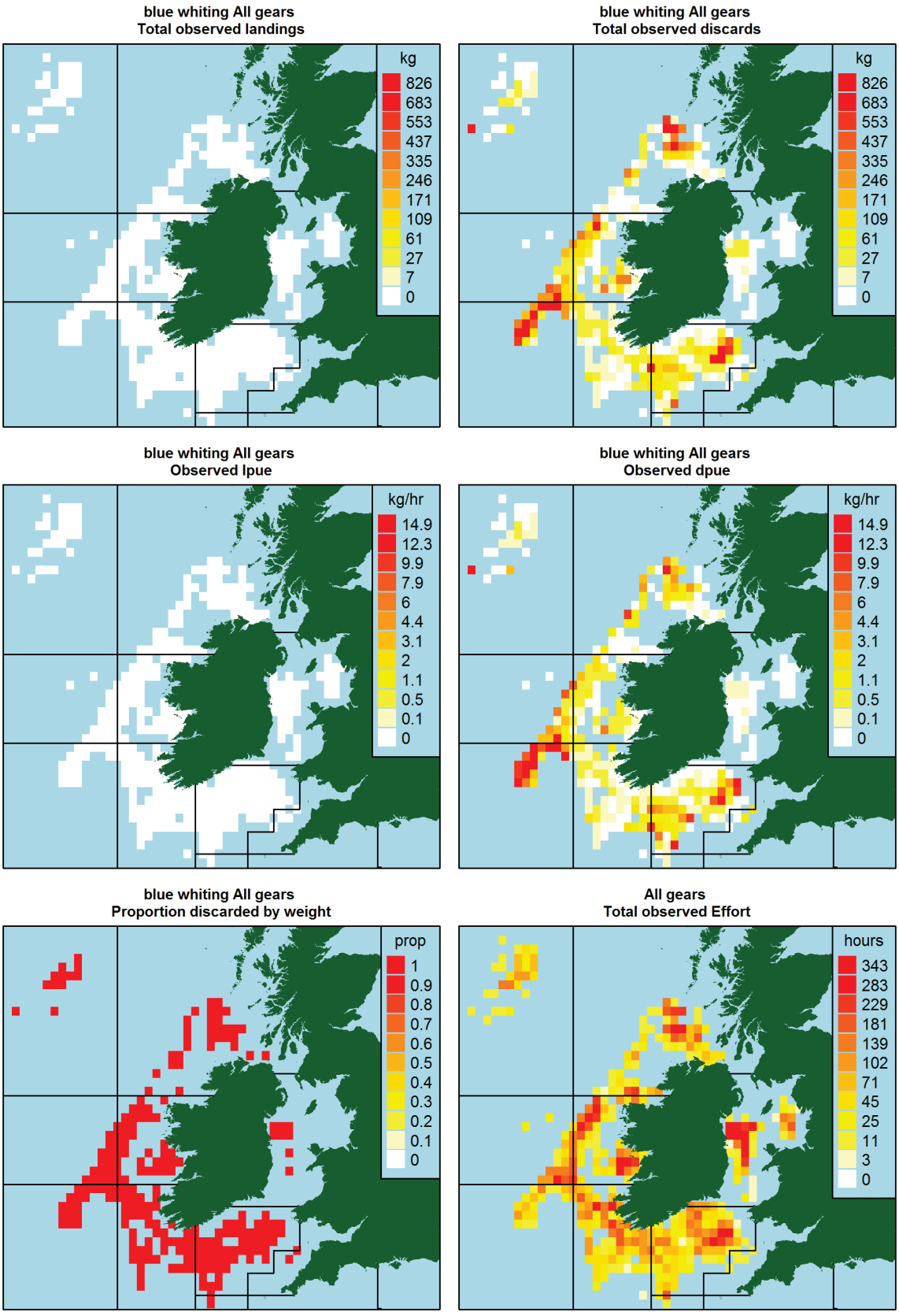


Figure 3.16 **Observed Blue Whiting Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Discards were observed all along the sampled areas with the exception of some coastal areas in VIIg and VIIa. Highest discards were observed along the Porcupine bank and to a lesser extent along the shelf edge. This pattern is also reflected in the DPUE. 100% of all blue whiting caught have been discarded.

Table 3.16 Total Blue Whiting Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	OTB VIIfgjk Dem	2,451.9	2,451.9	**81%**
	SSC VIIgj Dem	326.5	326.5	**11%**
	OTB VIIgfh Neph	228.0	228.0	**8%**
	GNS VIIbcgjk Dem	5.8	5.8	**0%**
	OTB VIIj Neph	3.1	3.1	**0%**
	TBB VIIefgh Dem	1.7	1.7	**0%**
	TOTAL	**3,017.1**	**3,017.1**	
Irish Sea	OTB VIIa Neph	7.6	7.6	**99%**
	TBB VIIa Dem	0.1	0.1	**1%**
	TOTAL	**7.8**	**7.8**	
Rockall	OTB VIb Dem	3.7	3.7	**100%**
	TOTAL	**3.7**	**3.7**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	829.7	829.7	**41%**
	OTB VIIck Neph	611.4	611.4	**30%**
	OTB VIIbc Dem	543.7	543.7	**27%**
	OTB VIIb Neph	46.1	46.1	**2%**
	TOTAL	**2,030.8**	**2,030.8**	
West of Scotland	OTB VIa Dem	182.7	182.7	**99%**
	OTB VIa Neph	1.6	1.6	**1%**
	TOTAL	**184.3**	**184.3**	

Key Observations for Table

Highest discards of blue whiting were observed in the Celtic Sea in the OTB VIIfgjk Dem métier which accounted for 81% of the overall discards.

Key Observations for Blue Whiting Discarding Practices

There is no commercially demersal directed fishery for blue whiting although the species is of major interest to pelagic fisheries. Given the landings associated with pelagic fleets, the impact of blue whiting discards associated with demersal fisheries are negligible.

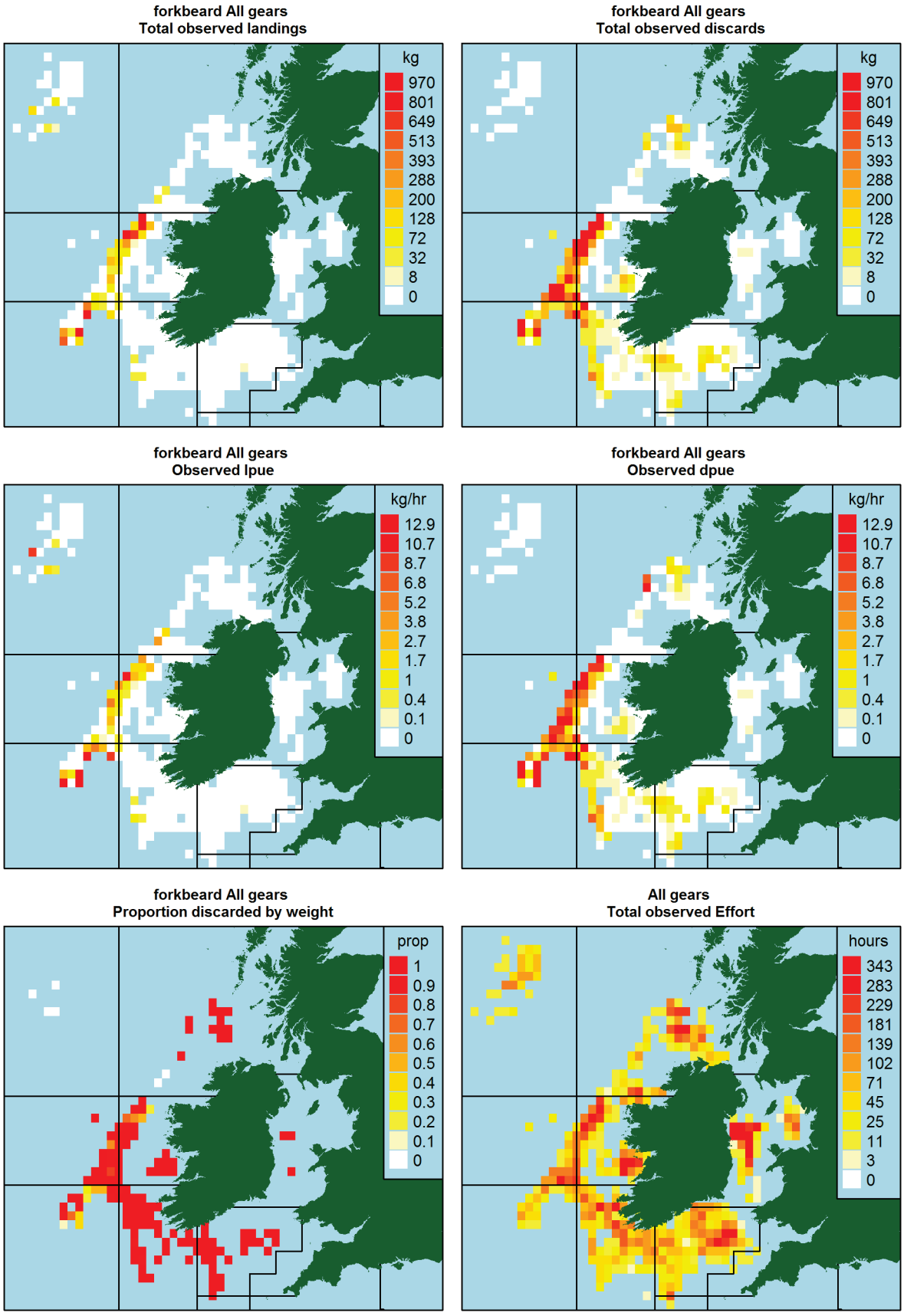


Figure 3.17 **Observed Forkbeard Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

While the majority of forkbeard are discarded, some landings were observed along the shelf edge. Discards are largely confined to the Porcupine bank and 200m depth contour. DPUE levels also reflect this pattern and varied from between 2-12.9kg per hour.

Table 3.17 Total Forkbeard Catch by Métier from 2003-2009.

Area	Métier	Discards	Landings	Total Catch	% Contribution
Celtic Sea	OTB VIIfgjk Dem	335.7		335.7	**86%**
	TBB VIIefgh Dem	33.6	0.3	33.9	**9%**
	OTB VIIgfh Neph	15.6		15.6	**4%**
	OTB VIIj Neph	4.4		4.4	**1%**
	SSC VIIgj Dem	1.2		1.2	**0%**
	GNS VIIbcgjk Dem	0.3		0.3	**0%**
	TOTAL	**390.7**	**0.3**	**391.0**	
Irish Sea	OTB VIIa Neph	0.9		0.9	**52%**
	TBB VIIa Dem	0.8		0.8	**48%**
	TOTAL	**1.7**		**1.7**	
Rockall	OTB VIb Dem		1.1	1.1	**0%**
	TOTAL		**1.1**	**1.1**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	2,419.0	9.9	2,428.9	**86%**
	OTB VIIck Neph	277.9		277.9	**10%**
	OTB VIIbc Dem	122.3		122.3	**4%**
	OTB VIIb Neph	8.6		8.6	**0%**
	TOTAL	**2,827.9**	**9.9**	**2,837.7**	
West of Scotland	OTB VIa Dem	19.9		19.9	**98%**
	OTB VIa Neph	0.4		0.4	**2%**
	TOTAL	**20.3**		**20.3**	

Key Observations for Table

Highest discards were observed in the OTB VIa VIIbcjk Meg & Monk métier. Notably, this was the most predominant métier for forkbeard discards compared to all others.

Key Observations for Forkbeard Discarding Practices

Discards for this species are spatially confined to the Porcupine bank.

Poor Cod

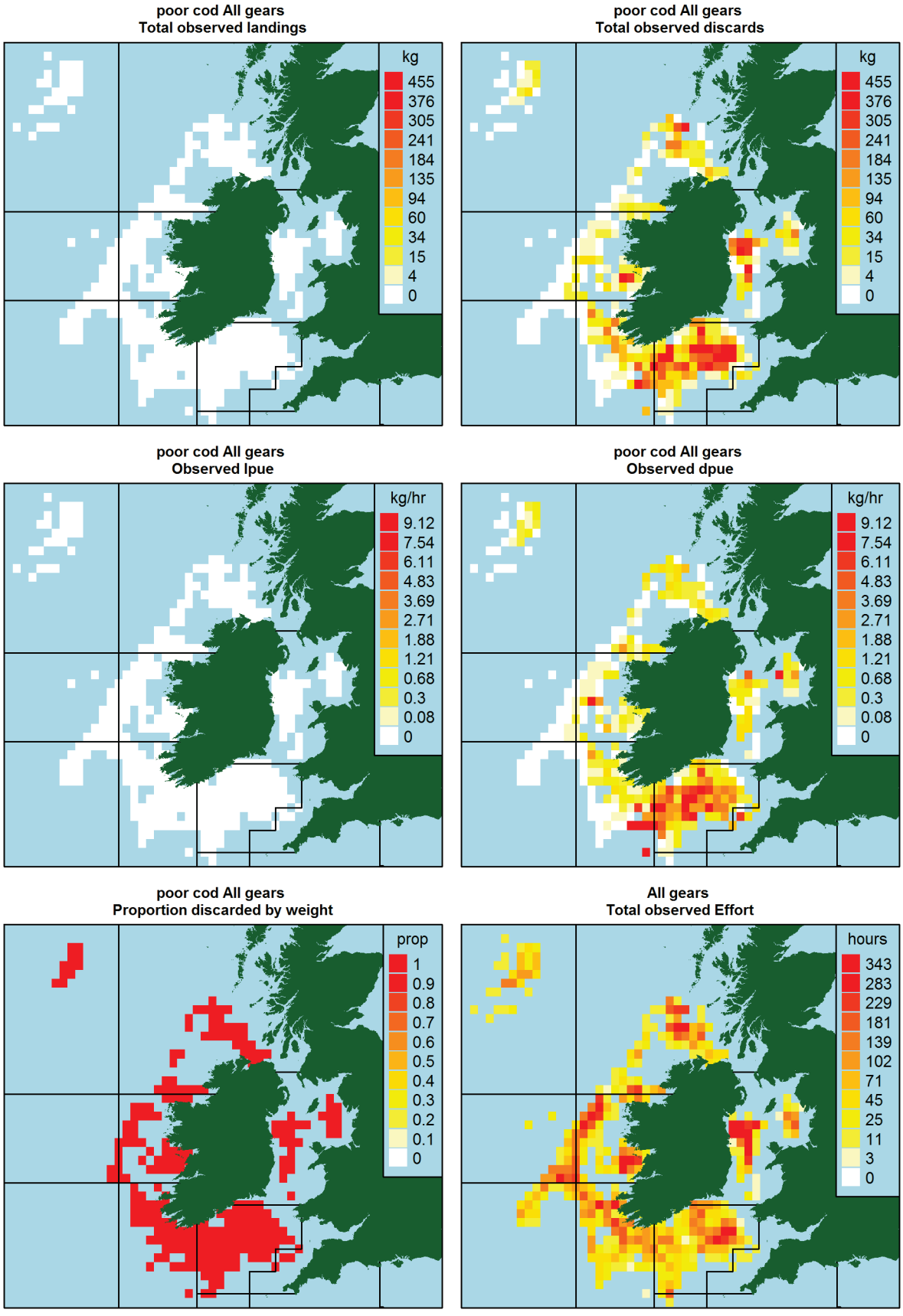


Figure 3.18 **Observed Poor Cod Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Highest levels of poor cod discards were observed in the Celtic Sea and Western Irish Sea. Highest DPUE values have been observed in the Celtic sea. All poor cod caught were discarded.

Table 3.18 Total Poor Cod Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	SSC VIIgj Dem	744.6	744.6	**33%**
	OTB VIIgfh Neph	739.6	739.6	**33%**
	OTB VIIfgjk Dem	586.6	586.6	**26%**
	TBB VIIefgh Dem	136.3	136.3	**6%**
	OTB VIIj Neph	23.5	23.5	**1%**
	GNS VIIbcgjk Dem	0.5	0.5	**0%**
	TOTAL	**2,231.1**	**2,231.1**	
Irish Sea	OTB VIIa Neph	288.7	288.7	**78%**
	TBB VIIa Dem	72.5	72.5	**19%**
	SSC VIIa Dem	10.8	10.8	**3%**
	TOTAL	**372.0**	**372.0**	
Rockall	OTB VIb Dem	9.7	9.7	**100%**
	TOTAL	**9.7**	**9.7**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	218.0	218.0	**69%**
	OTB VIIb Neph	53.5	53.5	**17%**
	OTB VIIbc Dem	46.1	46.1	**15%**
	TOTAL	**317.5**	**317.5**	
West of Scotland	OTB VIa Dem	96.6	96.6	**96%**
	OTB VIa Neph	3.6	3.6	**4%**
	TOTAL	**100.2**	**100.2**	

Key Observations for Table

The Celtic Sea was observed to have the highest discards of poor cod across all areas. Within the Celtic sea, there were three métiers which contributed to the majority of the discards, SSC VIIgj Dem, OTB VIIgfh Neph and OTB VIIfgjk Dem.

Key Observations for Poor Cod Discarding Practices

This species has no commercial value. They are an important prey species for other gadoid fish.

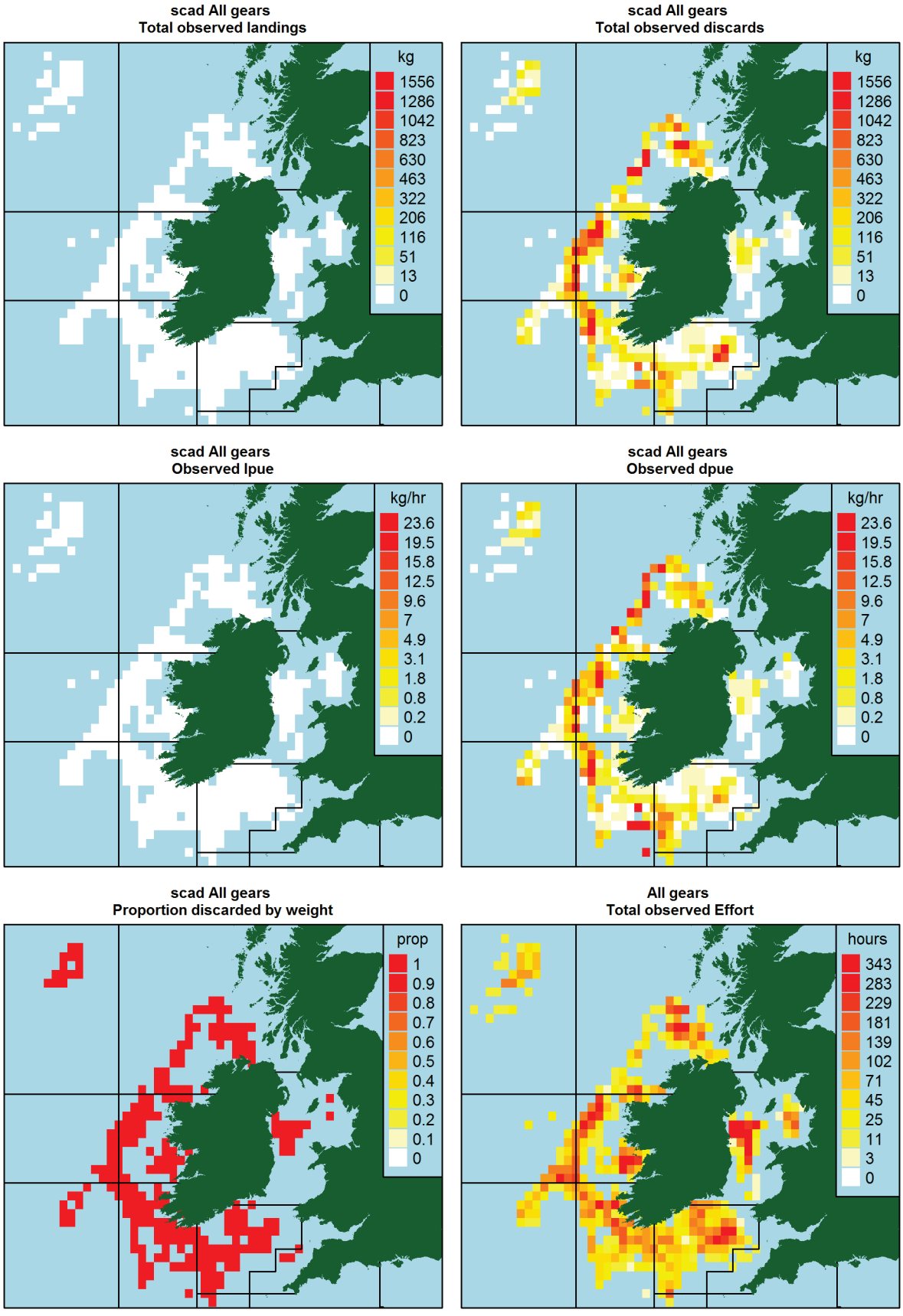


Figure 3.19 **Observed Scad Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Discards of scad were predominantly observed on the west coast where average DPUE levels of between 9-23.6kg per hour were observed.. There were no landings of scad observed as there are no demersal directed fisheries for scad. 100% of scad caught were observed to have been discarded by the demersal fisheries.

Table 3.19 Total Scad Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	SSC VIIgj Dem	501.0	501.0	**59%**
	GNS VIIbcgjk Dem	162.7	162.7	**19%**
	OTB VIIfgjk Dem	131.9	131.9	**16%**
	OTB VIIgfh Neph	53.8	53.8	**6%**
	OTB VIIj Neph	0.9	0.9	**0%**
	TBB VIIefgh Dem	0.0	0.0	**0%**
	TOTAL	**850.3**	**850.3**	
Irish Sea	OTB VIIa Neph	6.6	6.6	**79%**
	OTB VIIa Dem	1.7	1.7	**21%**
	TOTAL	**8.2**	**8.2**	
Rockall	OTB VIb Dem	10.7	10.7	**100%**
	TOTAL	**10.7**	**10.7**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	1,350.6	1,350.6	**87%**
	OTB VIIbc Dem	150.2	150.2	**10%**
	OTB VIIb Neph	37.6	37.6	**2%**
	OTB VIIck Neph	8.5	8.5	**1%**
	TOTAL	**1,546.9**	**1,546.9**	
West of Scotland	OTB VIa Dem	403.8	403.8	**100%**
	TOTAL	**403.8**	**403.8**	

Key Observations for Table

Highest discards were observed in the OTB VIa VIIbcjk Meg & Monk métier in the West of Ireland.

Key Observations for Scad Discarding Practices

There is no commercially demersal directed fishery for scad although the species is of major interest to pelagic fisheries. Given the landings associated with pelagic fleets, the impact of scad discards associated with demersal fisheries are negligible. Discarding of this species is largely associated with métiers fishing off shore to the west of Ireland.

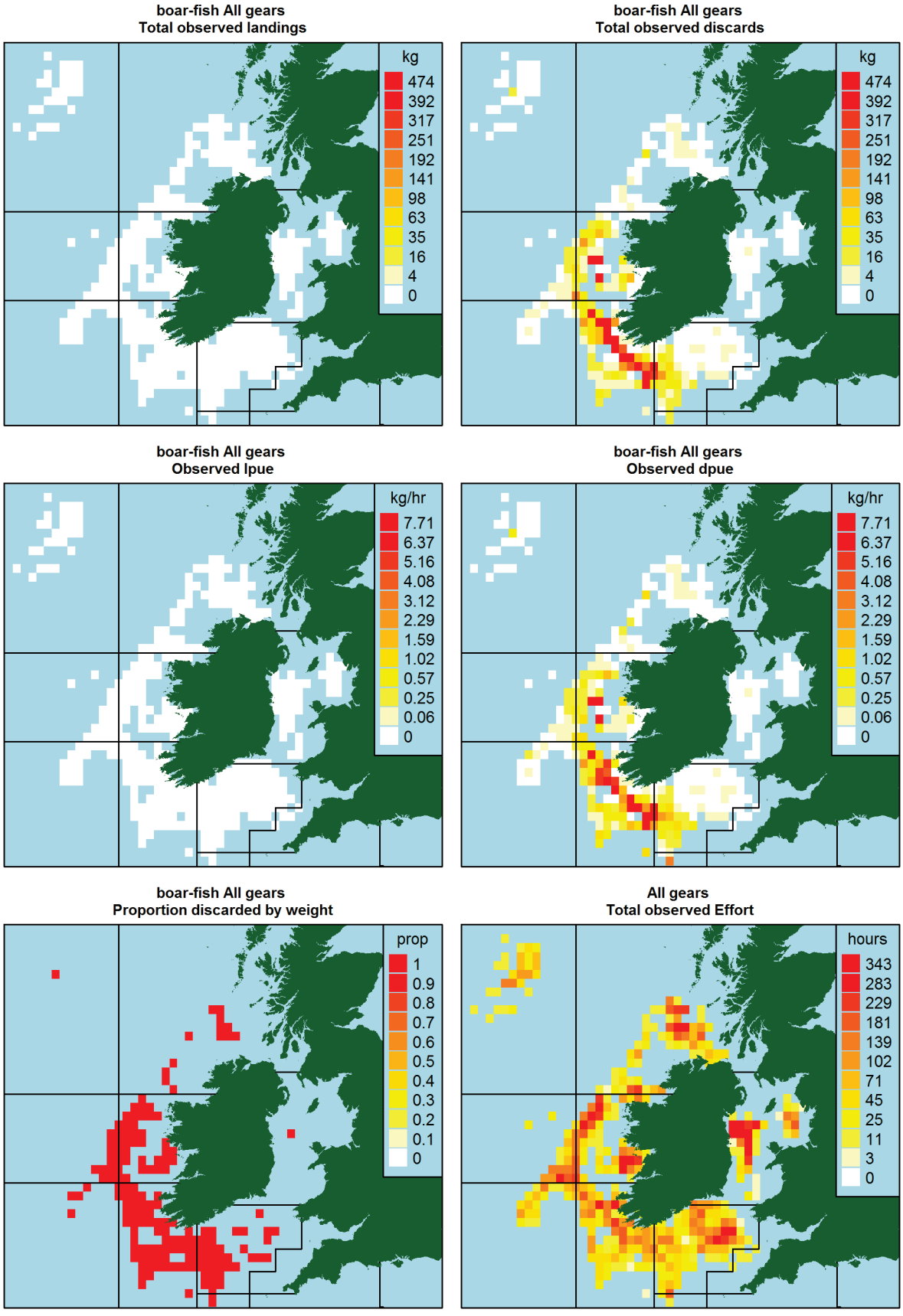


Figure 3.20 **Observed Boar-fish Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

There were no landings of boar-fish observed in the demersal catch sampling programme. Discards were mostly observed along the west and south west coast. This is also reflected in the DPUE patterns. 100% of boar-fish caught were discarded.

Table 3.20 Total Boar-fish Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	SSC VIIgj Dem	704.4	704.4	**61%**
	OTB VIIfgjk Dem	286.1	286.1	**25%**
	OTB VIIj Neph	122.6	122.6	**11%**
	OTB VIIgfh Neph	43.8	43.8	**4%**
	GNS VIIbcgjk Dem	0.4	0.4	**0%**
	TBB VIIefgh Dem	0.1	0.1	**0%**
	TOTAL	**1,157.4**	**1,157.4**	
Rockall	OTB VIb Dem	0.9	0.9	**100%**
	TOTAL	**0.9**	**0.9**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	907.7	907.7	**98%**
	OTB VIIb Neph	15.8	15.8	**2%**
	OTB VIIbc Dem	1.5	1.5	**0%**
	OTB VIIck Neph	1.2	1.2	**0%**
	TOTAL	**926.2**	**926.2**	
West of Scotland	OTB VIa Dem	1.4	1.4	**100%**
	TOTAL	**1.4**	**1.4**	

Key Observations for Table

The Celtic Sea and West of Ireland were the two most notable areas for boar-fish discards. Within the West of Ireland, the OTB VIa VIIbcjk Meg & Monk métier accounted for 98% of the discards. In the Celtic Sea, the main métier was the SSC VIIgj Dem métier, contributing to 61% of the discards.

Key Observations for Boar-fish Discarding Practices

Boar-fish is a small pelagic fish and in recent years a targeted fishery by pelagic vessels has rapidly expanded for production of fishmeal. However, there are no landings of this species by demersal vessels. Discards however can occur when demersal vessels come upon catches of this shoaling species. However, given the relative scale of the pelagic fishery, discards associated with demersal métiers are negligible.

ARGENTINE

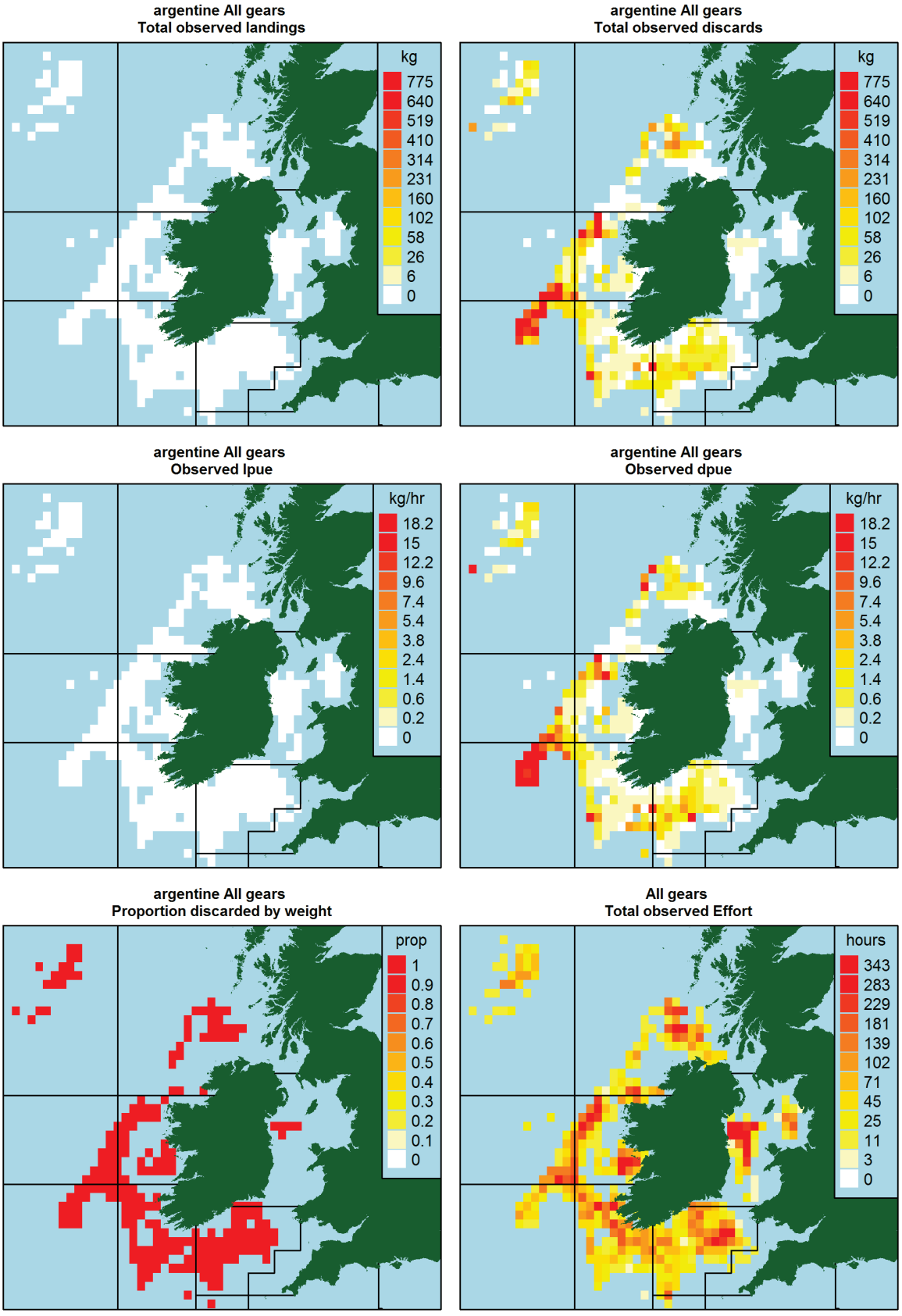


Figure 3.21 **Observed Argentine Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Highest discards were observed along the west coast, specifically in the Porcupine Bank and the south coast. This pattern is also reflected in the DPUE. All argentines caught were discarded.

Table 3.21 Total Argentine Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	SSC VIIgj Dem	555.4	555.4	**58%**
	OTB VIIfgjk Dem	388.0	388.0	**41%**
	OTB VIIgfh Neph	8.6	8.6	**1%**
	TBB VIIefgh Dem	4.1	4.1	**0%**
	TOTAL	**956.1**	**956.1**	
Irish Sea	OTB VIIa Neph	0.0	0.0	
	TOTAL	**0.0**	**0.0**	
Rockall	OTB VIb Dem	4.2	4.2	**100%**
	TOTAL	**4.2**	**4.2**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	370.3	370.3	**51%**
	OTB VIIck Neph	349.2	349.2	**48%**
	OTB VIIbc Dem	11.6	11.6	**2%**
	OTB VIIb Neph	1.8	1.8	**0%**
	TOTAL	**732.9**	**732.9**	
West of Scotland	OTB VIa Dem	196.8	196.8	**100%**
	OTB VIa Neph	0.0	0.0	
	TOTAL	**196.8**	**196.8**	

Key Observations for Table

The Celtic Sea and West of Ireland were the two principal areas for argentine discards. Within the Celtic Sea there were two main métiers which accounted for overall discards: SSC VIIgj Dem and OTB VIIfgjk Dem. In the West of Ireland, the OTB VIa VIIbcjk Meg & Monk and OTB VIIck Neph métiers accounted for 51% and 48% of the overall discards, respectively.

Key Observations for Argentine Discarding Practices

Discarding of this species is largely confined to the Porcupine Bank. Argentines are a pelagic species, not targeted by demersal fisheries.

LONG ROUGH DAB

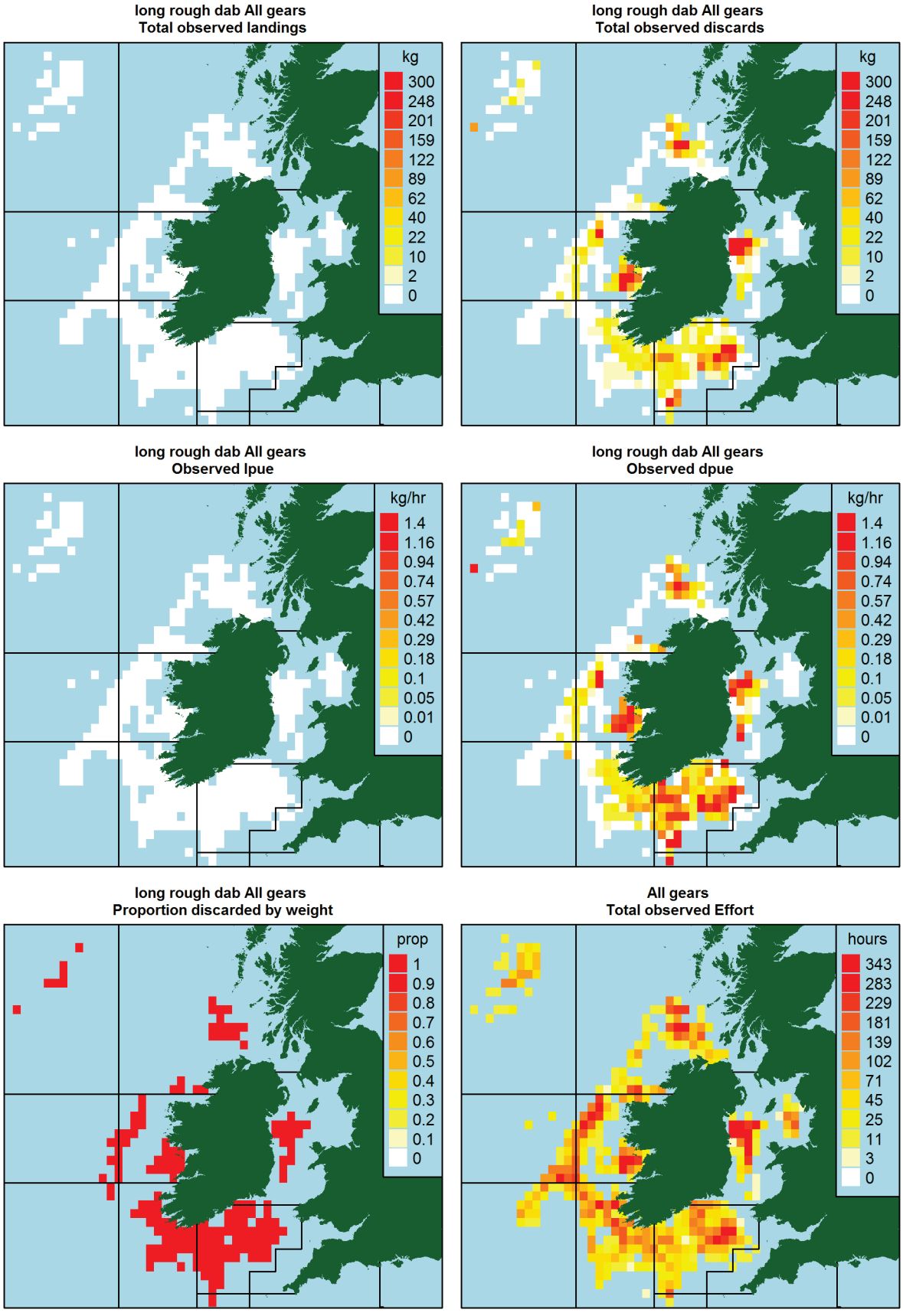


Figure 3.22 **Observed Long Rough Dab Landings, Discards and effort from Discard Sampling Trips carried out between 1995-2009.**

Key Observations for Maps

Highest discards were observed along the south east coast, and also in coastal areas in VIIb and VIIa. This pattern is also reflected in the DPUE. All long rough dab caught were discarded.

Table 3.22 Total Long Rough Dab Catch by Métier from 2003-2009.

Area	Métier	Discards	Total Catch	% Contribution
Celtic Sea	OTB VIIgfh Neph	301.5	301.5	**43%**
	TBB VIIefgh Dem	261.2	261.2	**37%**
	OTB VIIfgjk Dem	108.3	108.3	**15%**
	SSC VIIgj Dem	26.1	26.1	**4%**
	OTB VIIj Neph	9.2	9.2	**1%**
	GNS VIIbcgjk Dem	0.2	0.2	**0%**
	TOTAL	**706.4**	**706.4**	
Irish Sea	OTB VIIa Neph	194.7	194.7	**96%**
	TBB VIIa Dem	7.0	7.0	**3%**
	OTB VIIa Dem	0.3	0.3	**0%**
	TOTAL	**202.0**	**202.0**	
Rockall	OTB VIb Dem	0.0	0.0	
	TOTAL	**0.0**	**0.0**	
West of Ireland	OTB VIa VIIbcjk Meg & Monk	141.3	141.3	**39%**
	OTB VIIb Neph	127.5	127.5	**35%**
	OTB VIIbc Dem	94.2	94.2	**26%**
	TOTAL	**362.9**	**362.9**	
West of Scotland	OTB VIa Dem	17.5	17.5	**84%**
	OTB VIa Neph	3.4	3.4	**16%**
	TOTAL	**20.9**	**20.9**	

Key Observations for Table

Highest discards of long rough dab were observed in the Celtic Sea. Within this area, the OTB VIIgfh Neph and TBB VIIefgh Dem métiers accounted for 43% and 37% of the overall discards, respectively.

Key Observations for Long Rough Dab Discarding Practices

Discarding of long rough dab is generally associated with otter trawls using smaller meshes. Any improvements in mesh size selectivity will also help to reduce discarding of long rough dab.

4 MEASURES TO REDUCE DISCARDING

The previous sections of the Atlas have presented the scientific facts in relation to discarding in the demersal fleet. This section of the Atlas will now focus on measures to reduce discarding. A range of tools are available to manage by-catch and reduce discards including:

- Fishing capacity and effort controls;
- Improving the design and use of fishing gears;
- Spatial and temporal closures; and;
- Limits on by-catches

The performance of different measures to manage discards varies among fisheries as well as the costs associated with their effective implementation. Using parallel measures may increase their effectiveness. In many cases, industry 'buy–in 'will determine the effectiveness of the measures. It is therefore important that the cooperation of the industry and their involvement in all stages of selection, design and implementation of mitigation measures is maintained.

In the Irish fleet, beam and otter trawling have by far the highest levels of discards. There are a range of mitigation measures that can help reduce discard levels in the Irish trawl fisheries and in particular the *Nephrops* fishery, the beam trawl fishery for plaice and sole and the demersal whitefish fisheries.

In general terms, discard mitigation can be achieved through two principal mechanisms (i) avoiding or closing areas with high concentrations of juveniles or unwanted species (ii) through technical modification to the fishing gear.

Tactical Mitigation

Spatial and temporal measures such as seasonal closures of specific areas, can help limit the amount of unwanted fish and have been successfully applied in a number of jurisdictions. 'Moving On' procedures where fishers are required to move away from areas where their catch composition is outside predefined limits, such as the number of juveniles per kilogramme, are also used e.g. Barents Sea, Bering Sea. In a review of management frameworks and their influence on fishing gear selectivity [2] it was found that setting limits based on the composition of the catch in the net - not to be confused with catch composition limits commonly used in EC fisheries that only limit the catch retained onboard – can act as a significant incentive to improve gear selectivity or for fishermen to adopt other tactical avoidance measures such as fishing only at certain times of the day. Work is currently ongoing in Ireland to produce maps that show where the highest levels of discards are occurring (Figure 4.1). In time it is hoped that the generation of such maps could help fishermen avoid discard 'hot spots'. Such an approach is used in the Bering Sea and Aleutian Islands Pollock fishery, where the breaching of prohibited by-catch limits can result in premature closure of the fishery [2].

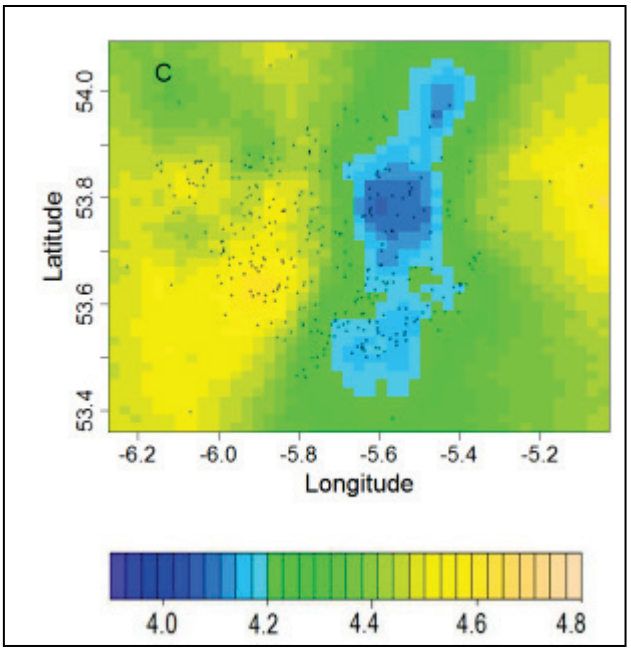


Figure 4.1 Prediction surface of Log Discards per Unit of Effort from the Irish Sea based on Marine Institute sampling data (black dots).

The work being undertaken by Trinity College, Dublin has also demonstrated that there are seasonal and even daily patterns in discard levels in the *Nephrops* fishery in the Irish Sea. The continuation of this type of work, coupled to the generation of discard 'heat maps' will allow for more tactical methods to avoid discards. There are also a wide range of gear related technical measures that help reduce the levels of discards.

Technical Measures

The range of remedial technical measures can be broadly split into two categories, those that **improve size selection** of target or by-catch species and those that **reduce the overall by-catch** through species selection.

Where several species are targeted which have similar morphological characteristics (i.e. fish with the same size and shape), manipulation of the mesh size and/or shape or the inclusion of another modification to the trawl such as the inclusion of a square mesh panel, may be sufficient to reduce the level of discards.

The situation is more complex when significant morphological characteristics (i.e. fish with different size and shape) exist between a range of the target and non-target species. This is typical of fisheries with a "target species mix" and particularly those where crustaceans form an important component of the catch. The small mesh size necessary to retain the target species often results in the retention of 'juvenile' or unwanted fish species. Reducing discard levels in these fisheries is more complex and technically challenging. Even a relatively small increase in mesh size is likely to result in high losses of target species while having a marginal impact on the retention of unwanted species. Therefore, alternative mechanisms are needed.

One of the simplest measures is the alteration of the cod-end construction (i.e. end of the trawl) with the aim of increasing the area of open meshes. This will allow more of the catch to escape. This can be done by increasing mesh size, for example, or by constructing the cod-end entirely from **square meshes** which do not close under tension. [9] For fish and *Nephrops*, the twine used in the construction of the cod-end can also influence selectivity. Restricting the number of individual twines, the twine thickness or the twine stiffness reduces the mesh resistance to opening [10].

With the exception of mesh size and mesh construction, the square mesh panel (Figure 4.2) is one of the most common 'additional' devices tested. It was first introduced into legislation in 1992 in the Northern European *Nephrops* fisheries for improving the size selection of gadoids (i.e. allowing more of the smaller gadoids to escape). [11] The panel relies on utilising the natural escape behaviour of the fish and assisting escape by maintaining an open mesh structure. Recent research on fish trawls has shown that as well as panel mesh size, panel position relative to the cod-end is critical. [12,13].

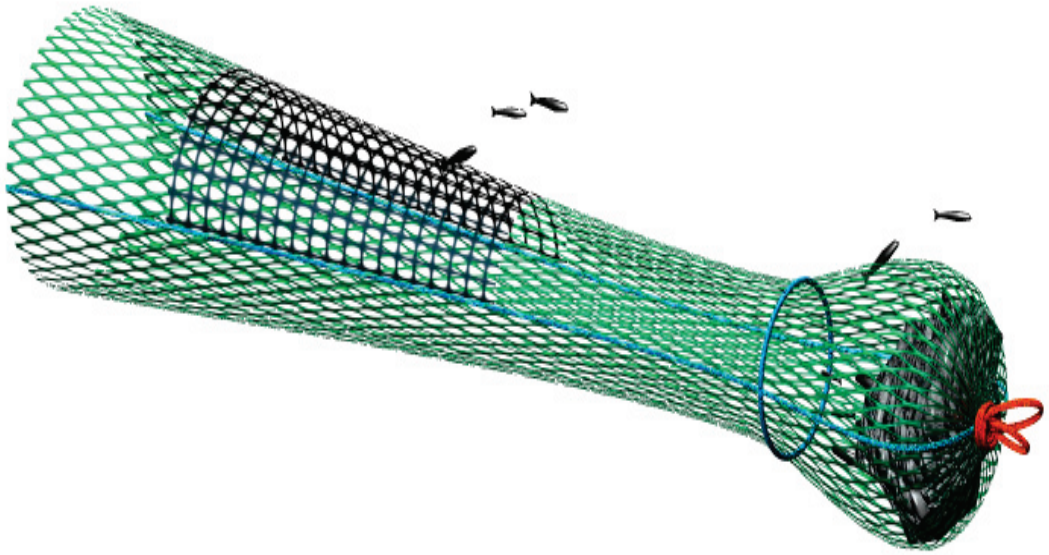


Figure 4.2 Square mesh panel inserted into a conventional diamond mesh cod-end. (Crown Copyright, courtesy of Marine Scotland).

The need to improve selectivity and reduce the capture of small fish (i.e. below Minimum Landing Size; MLS) in the Norwegian Barents Sea demersal fishery was recognised by managers and industry. In the 1980s, Norway introduced area closures and the obligation for vessels to switch fishing ground if the catch composition has in excess of 15% of fish below minimum catch size [MCS; note the distinction between catch rather than landing size]. However, increasing cod-end mesh size to adhere to the catch limits would have resulted in significant losses of marketable fish. As an alternative, **rigid grids** (Figure 4.3) were developed and are now mandatory in the Barents Sea demersal trawl fishery. The rigid and semi-rigid grids have been assessed in the North Sea demersal trawl fisheries [14, 15] . The results indicated that there was no evidence to support the view that their selective properties are any superior to cod-end mesh selection.

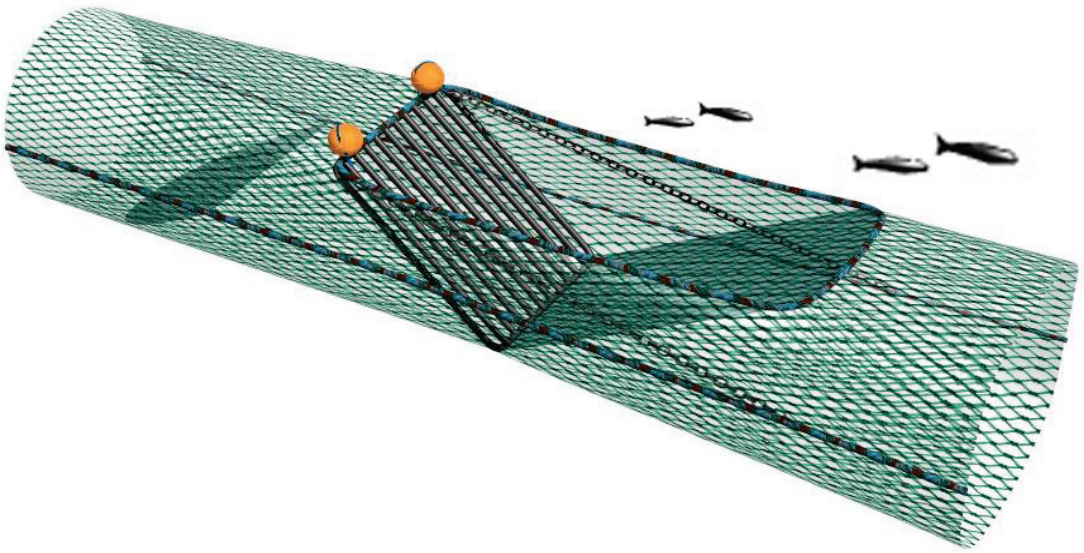


Figure 4.3 Rigid size selective grid inserted in the extension piece of a trawl. (Crown Copyright, courtesy of Marine Scotland).

By utilising differences in vertical fish behavioural patterns at the mouth of the trawl, the horizontal panel separator trawl (Figure 4.4) was developed in order to segregate species into specific areas within the net. A single panel of netting is inserted horizontally within the trawl, dividing the trawl into upper and lower components. This is known as a **separator panel**. *Nephrops,* cod and flatfish species remain close to the lower part of the net and are retained in the lower cod-end. Higher swimming species such as whiting and haddock are retained in the upper cod-end. [16, 17, 18].

This allows the use of different mesh sizes in the upper and lower cod-ends that are better suited to the species retained in each. These designs have been tested extensively in the mixed fish/*Nephrops* fisheries in the North and Irish Seas and the West of Scotland, where larger mesh upper cod-ends were used to improve haddock and whiting selectivity, while the lower cod-end is constructed from smaller mesh to retain *Nephrops*.

The design shown in Figure 4.4 also includes a series of rising ropes, which have been shown to guide cod into the upper cod-end. While the designs do achieve the desired effect, due to rigging complexities, they have never been adopted on a commercial basis.

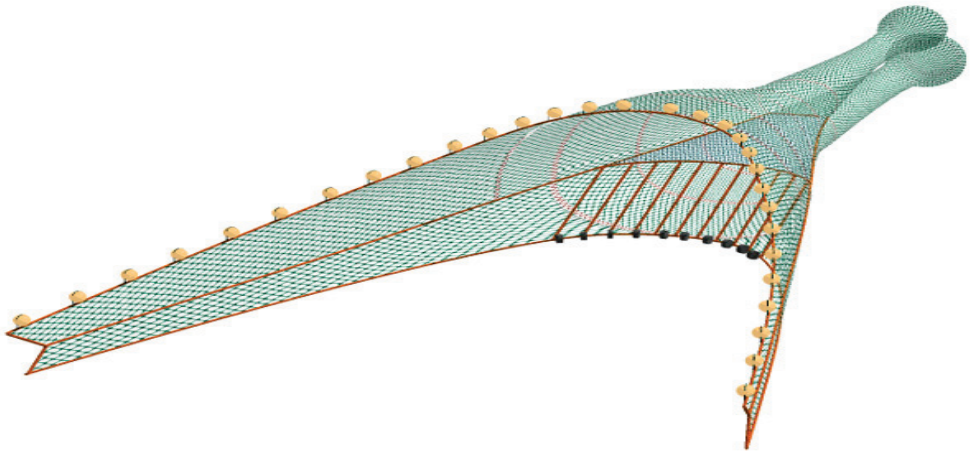


Figure 4.4 Horizontal separator trawl with additional guiding ropes to encourage cod into the upper chamber. (Crown Copyright, courtesy of Marine Scotland).

The **inclined separator panel** (Figure 4.5) is fitted into the modified extension piece of a standard *Nephrops* trawl to divert cod and other whitefish species towards an escape hole in the top of the trawl [19]. The panel starts 50 meshes above the cod-end with the leading edge approximately 30cm above the bottom sheet, allowing the passage of *Nephrops* and other species such as monk and flatfish into the cod-end, while guiding the cod, haddock and whiting out of the escape hole.

The panel was specifically developed for *Nephrops* fisheries in the Irish Sea to minimise the cod catches as part of the Irish Sea cod recovery plan (*Commission Regulation* (EC) No. 1456/2001). The use of the separator panel is mandatory when fishing for *Nephrops* inside designated areas in the Irish Sea from February 14 to 30 April.

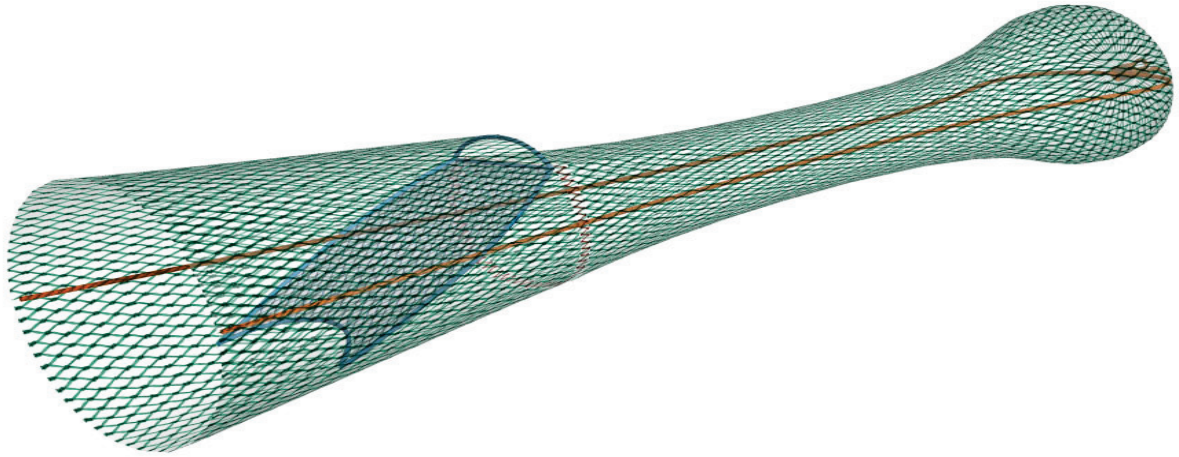


Figure 4.5 Separator panel inserted into the extension and cod-end of a *Nephrops* trawl. (Crown Copyright, courtesy of Marine Scotland).

The **Nordmøre grid** (Figure 4.6) is used widely in temperate and tropical shrimp fisheries to exclude unwanted by-catch [20]. It is commonly used in the temperate *Pandalus* shrimp fishery and in tropical fisheries for the exclusion of turtles as well as fish. The device comprises a series of parallel bars spaced to allow the shrimp to pass through the grid into the cod-end while larger animals are diverted out of the trawl.

The **grid** (also known as the 'Swedish Grid') is mandatory in the Swedish *Nephrops* fishery in the Skagerrak and is now used by three Irish *Nephrops* vessels in the Irish Sea. Its use has allowed these vessels to be exempted from effort restrictions under the Long Term Management Plan for cod as it has been proven to maintain cod catches well below the 1.5% threshold set out in the regulation. In addition to almost eliminating the capture of cod, the grid is also highly effective at reducing the capture of other fish species. The use of the grid also greatly reduces the capture of marketable fish by-catch but this is offset by the removal of effort restrictions. See section 5 for further details.

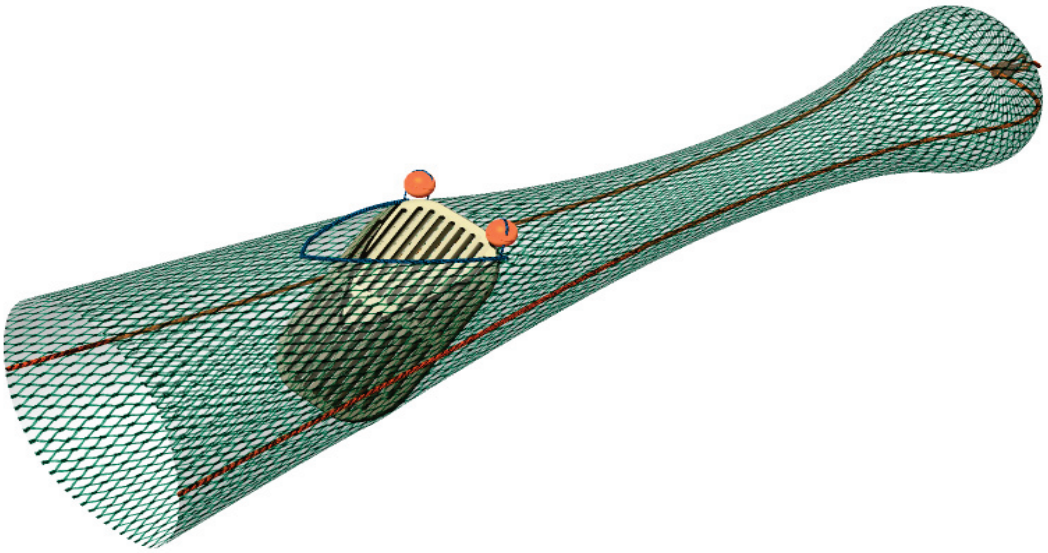


Figure 4.6 **A rigid separator grid used to exclude fish and marine mammal by-catch in shrimp trawls. (Crown Copyright, courtesy of Marine Scotland).**

Choosing the appropriate mitigation tool

The causes of discarding are diverse (see page 5) and therefore the appropriate method to minimise discards need to be tailored to the specific causes and drivers of the discard issue in any given fishery. The options presented above may offer several potential solutions. However, the selection of the most appropriate measure or suite of measures, needs to be sympathetic and tailored to the particular circumstances in the fishery.

There are a range of mitigation measures that can help reduce discard levels in the Irish trawl fisheries and in particular the *Nephrops* fishery, the beam trawl fishery for plaice and sole and the demersal whitefish fisheries. Such measures can include spatial and temporal avoidance (**tactical mitigation)** or adjustments to fishing gear design (**technical mitigation)**. The range of technical measures can be broadly split into two categories, those that improve size selection of target or by-catch species and those that reduce the overall by-catch through species selection. Increasing mesh size, the inclusion of square mesh panels, rigid grids and separator panels in the trawl gear can be used to reduce discards. Maximising discard reduction required the selection of the appropriate mitigation approach and one that is tailored to the discard characteristics and drivers of each fishery.

5 How to Reduce Discarding in Irish Fisheries – two case studies

The scientific data presented in this Atlas clearly show that there is a need to reduce discarding in a number of Irish fisheries. Two main fleet groups stand out from the data – the otter trawl fishery targeting mixed whitefish species in the Celtic Sea and the *Nephrops* métiers.

In this section we demonstrate the potential of technical measures for reducing discards in these two fisheries.

Case Study 1 – Demersal Trawls and Seine Fisheries in the Celtic Sea

There are several discrete métiers exploiting demersal whitefish operating in the Celtic Sea. These target a wide range of mixed species including cod, haddock and whiting as well as a number of important flatfish species such as megrim, black sole and lemon sole. Table 5.1 lists the top 10 demersal species (by weight) landed in 2009.

Table 5.1 Top 10 most important species by weight for Irish demersal fleets operating in the Celtic Sea (2009 landings: Source Irish Logbook Database).

Species	Weight (t)
Cod	567.96
Haddock	2,436.04
Hake	926.13
Lemon Sole	246.85
Megrim	1,621.00
Monkfish	1,788.52
Nephrops	3,123.96
Ray	306.63
Whiting	2,560.83
Witch	297.39

Analysis of EU log book landings data, identifies 6 métiers using demersal gears (otter trawls, Scottish Seines and beam trawls) targeting demersal whitefish species or *Nephrops.* The Atlas data show that all of these métiers have high discard rates for both commercial and non-commercial species. Such discarding represents under-utilisation of the resource where potential revenue is being caught and subsequently discarded. From a business perspective this makes little sense.

Discard levels do not need to be this high and simple changes in mesh size or the inclusion of a square mesh panel can drastically reduce discards. In the Celtic Sea, the current minimum mesh size depends on the catch composition.

Where a vessel retains >35% *Nephrops* , it is permissible to use a mesh size in the range of 70-79mm; whereas, mesh sizes in the range of 80-99mm must be used when targeting mixed demersal species. Unusually, there is no requirement to use a square mesh panel in either fishery.

The majority of EU trawl fisheries using mesh sizes <100mm must have a square mesh panel inserted (Figure 5.1). A combination of increasing the mesh size used and the addition of a square mesh panel could significantly reduce the level of both haddock and whiting discards.

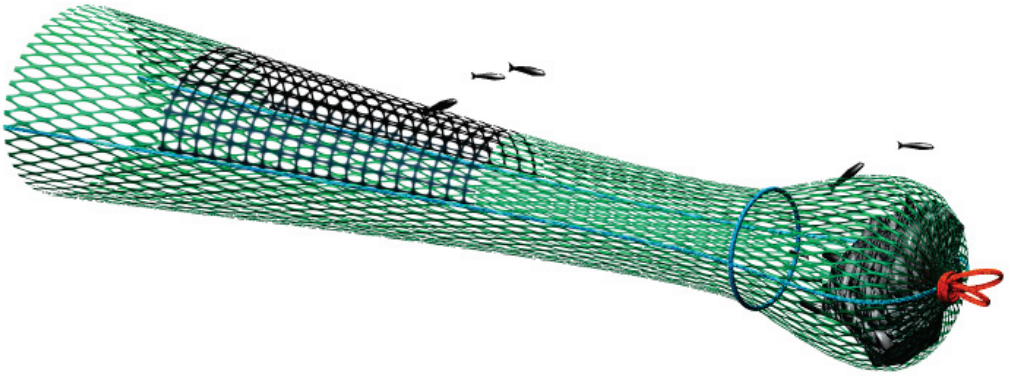


Figure 5.1 Square mesh panel inserted into a conventional diamond mesh cod-end. (Crown Copyright, courtesy of Marine Scotland).

Here we take the example of Celtic sea haddock and whiting to illustrate the point.

Information collected from observers show that substantial quantities of haddock and whiting are discarded each year in the Celtic Sea. While the *Nephrops* and beam trawl fisheries have the highest discard rate, ranging from 63% to 88% for haddock and whiting (Table 5.2), in terms of absolute weights discarded, the otter trawl (VIIg) and Scottish Seine (VIIgj) demersal fisheries contribute to 77% of the total haddock discards and 65% of the total whiting discards. This suggests that any mitigation measures to reduce discards should be targeted at theses two métiers.

Table 5.2 Breakdown of discards, landings, discard rates by demersal Irish métier using towed gears in the Celtic Sea (2003 – 2009) and overall contribution made by each to absolute discard levels.

Métier	Species	Discards (tonnes)	Landings (tonnes)	Discard rate	% Overall Discards
OTB VIIfgjk Dem	Haddock	6,902.7	8,624.2	44%	44%
SSC VIIgj Dem	"	5,263.6	5,677.7	48%	33%
TBB VIIefgh Dem	"	1,816.0	1,059.5	63%	11%
OTB VIIgfh Neph	"	1,480.2	462.6	76%	9%
OTB VIIj Neph	"	331.9	123.3	73%	2%
OTB VIIfgjk Dem	Whiting	5,656.9	9,986.4	36%	45%
SSC VIIgj Dem	"	2,472.8	5,650.2	30%	20%
OTB VIIgfh Neph	"	4,124.6	953.7	81%	33%
TBB VIIefgh Dem	"	248.2	34.0	88%	2%
OTB VIIj Neph	"	103.3	31.1	77%	1%

To illustrate what the impact on landings and discards would be by changing the cod-end mesh size and the inclusion of a square mesh panel, landings and discard length data are used to predict what the catch profile would have looked like if the fleet had been using alternative mesh sizes and a square mesh panel.
The current mesh size used is 90mm, constructed from 5.5mm single twine. Two possible scenarios are assessed, (i) increasing the cod-end mesh size to 100mm and adding a 110mm square mesh panel 9-12m from the codline and: (ii) increasing the cod-end mesh size to 90mm and adding a 110mm square mesh panel 9-12m from the codline.

The results are summarised in Table 5.3. For the 90mm cod-end, the current gear, from MI observer data, 33% by weight and 61% by number of haddock are discarded and 46% and 64% of whiting by weight and number respectively.

For both the 90/110mm and 100/120mm gear configurations, the impact on discard rates, overall discard levels and landings are given for both species by weight and number. For example, the impact on haddock catches (by weight) of using a 100mm cod-end with a 110mm square mesh panel, the discard rate falls to 9% from 33% and in absolute terms the amount of fish discarded is reduced by 81% with an associated 6% reduction in marketable fish.

Table 5.3 **Impact of the addition of a 110mm square mesh panel in the current gear (90/110mm) and the combined effect of increasing the mesh size to 100mm with the addition of a 110mm square mesh panel.**

		90mm	90/110mm	100/110mm
Haddock	Discard rate (wt)	33%	17%	9%
"	Discard rate (no)	61%	37%	22%
"	% Discard level (wt)		-59%	-81%
"	% Discard level (no)		-64%	-83%
"	% landings (wt)		-2%	-6%
"	% landings (no)		-3%	-10%
Whiting	Discard rate (wt)	46%	36%	32%
"	Discard rate (no)	64%	57%	55%
"	% Discard level (wt)		-56%	-71%
"	% Discard level (no)		-58%	-72%
"	% landings (wt)		-33%	-49%
"	% landings (no)		-43%	-59%

The effect on numbers of haddock landed and discarded is shown graphically in Figure 5.2. The red solid line shows the current discard profile, while the green shows the current landings profile based on MI observer data for 2009. The high rate of discarding (61%) is evident when comparing the discarded component with the landed. The predicted landings profile of increasing the mesh size and adding a square mesh panel is shown in dashed green. The change has a limited effect on the numbers of haddock landed (10% reduction), but there is a dramatic reduction in the numbers of haddock being discarded (dashed red), an estimated 83%.

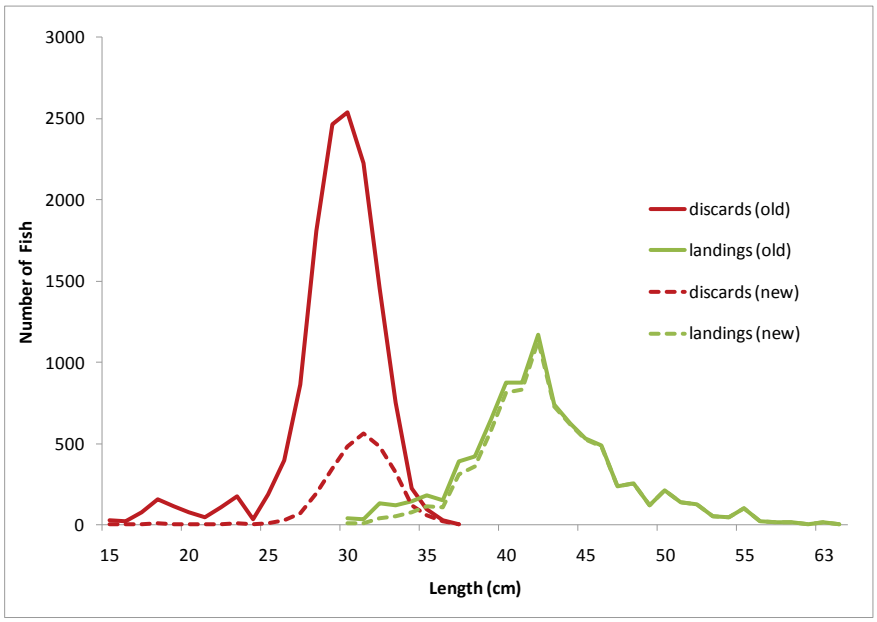


Figure 5.2 **2009 haddock catch profile landings (green solid line), discards (red solid line) and the estimated change in landings (green dashed line) and discards (red dashed line) if a 100mm cod-end fitted with a 110mm square mesh panel had been used in 2009.**

While the improvement in haddock selectivity results in a significant reduction in discards with a limited impact on landings, for whiting, the increase not only results in a significant reduction in discards of 72%, there is a substantial impact in the catch of marketable whiting, which is estimated to reduce by 59% by number and 49% by weight. This reduction can be seen in Figure 5.3.

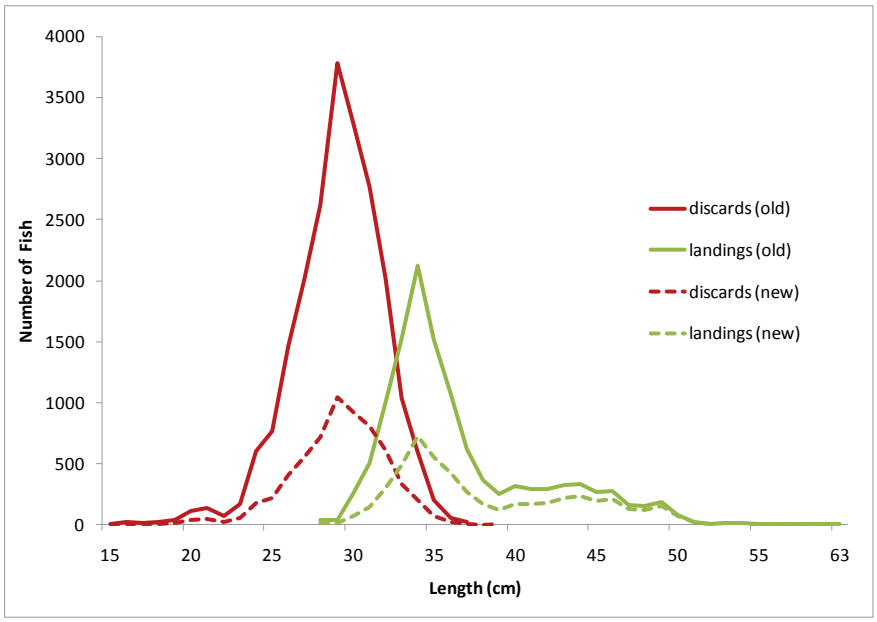


Figure 5.3 2009 whiting catch profile landings (green solid line), discards (red solid line) and the estimated change in landings (green dashed line) and discards (red dashed line) if a 100mm cod-end fitted with a 110mm square mesh panel had been used in 2009.

The reductions in haddock landings may be acceptable in terms of the longer term gains associated with the high reductions in discards, the high losses of marketable whiting are unlikely to be acceptable. To assess whether the losses in marketable whiting could be limited while still achieving reductions in haddock and whiting discards, the effect of adding a 110mm square mesh panel to the current cod-end (90mm) configuration is explored.

The results show that in terms of haddock discards and landings, the addition of a 110mm square mesh panel, still results in significant reductions in haddock discards (59% by weight) with almost no reduction in marketable catch (2% by weight). This is shown graphically in Figure 5.4.

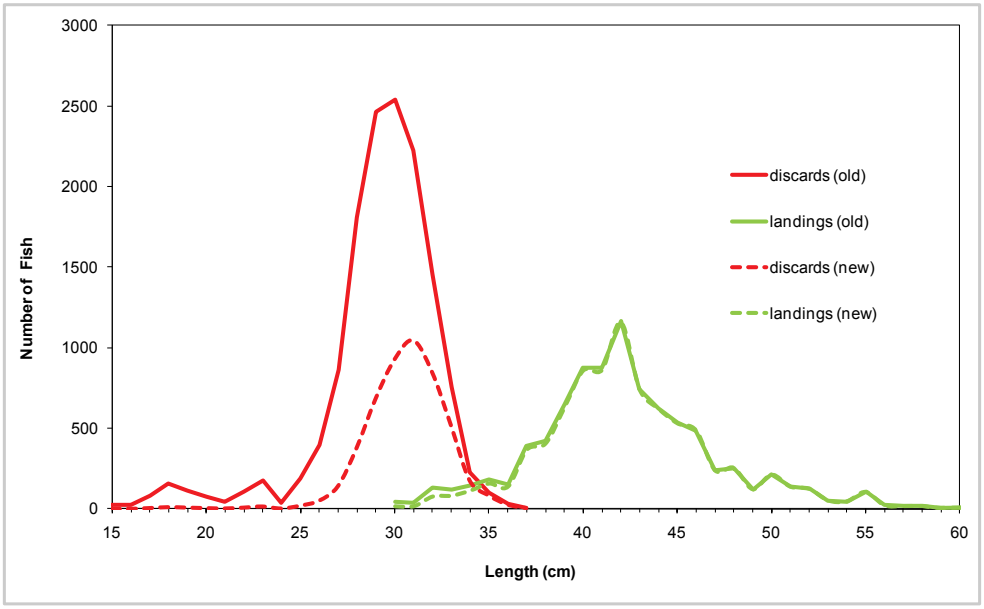


Figure 5.4 **2009 haddock catch profile landings (green solid line), discards (red solid line) and the estimated change in landings (green dashed line) and discards (red dashed line) if a 110mm square mesh panel had been fitted to the 90mm cod-end.**

However, the panel still results in a 33% (by weight) reduction in marketable whiting catches while giving a reduction in discards of 56%. The effect on whiting catch numbers is shown in Figure 5.5.

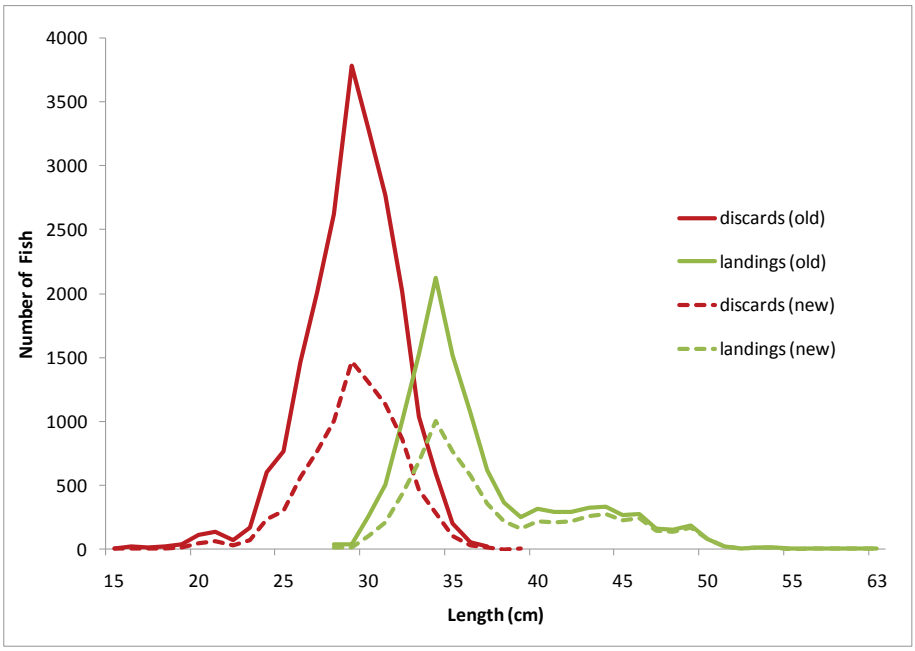


Figure 5.5 **2009 whiting catch profile landings (green solid line), discards (red solid line) and the estimated change in landings (green dashed green line) and discards (red dashed line) if a 110mm square mesh panel had been fitted to the 90mm cod-end.**

It is clear that discard rates in all trawl and seine fisheries in the Celtic Sea are excessively high. Reducing these levels will help improve the yield from the fishery and therefore contribute significantly in achieving maximum sustainable yield targets.

The analysis presented here shows that if improvements in cod-end selectivity via increases in mesh size (100mm) and the inclusion of a square mesh panel (110mm) had been implemented, substantial reductions in haddock and whiting discards would have been achieved, with limited impact on haddock landings.

However, under both scenarios, whiting landings are significantly impacted with the combined increase in cod-end mesh size and introduction of a 110mm square mesh panel. These losses could have been reduced through the application of the square mesh panel alone; albeit with lower corresponding reductions in discards.

It may be more acceptable from a commercial perspective if increases in selectivity are undertaken in a series of pre-agreed stages, this will help limit the short terms losses, and allow for better planning by the industry in terms of modifying gear.

Case Study 2 – The Impact of the 'Swedish' Grid in the Irish Sea *Nephrops* Fishery.

Nephrops fisheries are known to have high discard rates due to the small mesh size (~80mm) used to retain the target species [21]. The Irish *Nephrops* fishery conducted in the Irish Sea is no exception. Despite a range of technical measures and considerable research, discard rates are still excessively high in this fishery. Table 5.4 gives the landings, discards and discard rates of fish species associated with the Irish Sea *Nephrops* fishery.

Table 5.4 Landings, discards and discard rates of fish species associated with the Irish Sea *Nephrops* fishery (2003-2009) (Source discard sampling programme).

Species	Discards	Landings	Discard Rate
Whiting	6,543	11	100%
Nephrops	5,087	17,817	22%
Haddock	5,084	994	84%
Lesser Spotted Dogfish	3,085	-	100%
Grey Gurnard	3,010	2	100%
Plaice	2,997	652	82%
Dab	2,246	2	100%
Witch	405	152	73%
Poor Cod	372	-	100%
Long Rough Dab	202	-	100%
Monkfish	75	689	10%
Cod	65	594	10%
Hake	33	100	25%
Black Sole	21	505	4%
Megrim	20	1	94%
Scad	8	-	100%
Blue Whiting	8	-	100%
Forkbeard	2	-	100%
Saithe	1	1	56%
Grand Total	24,177	21,715	53%

A wide range of species are caught in the fishery, many of which have no commercial value and are discarded. While discarding of the main target species, *Nephrops*, is broadly sustainable the main management concerns related to catches of cod and whiting both of which are depleted [22]. Analysis of 2009 EU logbook landings composition and average prices shows that whitefish by-catch accounts for approximately 13% by value of the catch associated with Irish Sea *Nephrops* fisheries.

Since 2009, Irish trawl fisheries operating in the Irish Sea (VIIa) and the West of Scotland (VIa) have been subject to the EU Long term management plan for cod [23]. In both areas, this has resulted in annual reductions of 25% in effort allocations for the main otter trawl fleets. The cod management plan allows for vessels to be exempted from effort restrictions provided that they can demonstrate that their cod *catch* is below 1.5%. The fact that it is the catch not the landing that must be below 1.5% is significant. The majority of EC regulations of controlling catches are in fact done through the monitoring of landings. This approach to monitoring catches is growing as a management approach within EC fisheries and it reverses the burden of proof in that fishermen must now demonstrate through the use of scientific observers, that their cod catch is below the threshold [24].

In the Irish Sea, BIM, the Marine Institute have collaborated and assisted several local fishermen to use technical measures to reduce cod catches by using a selection grid (Figure 4.6). To date, three vessels have been successful in being exempted from effort restrictions in the Irish Sea. This has required and continues to require significant levels of observer coverage to monitor catches.

This monitoring has shown that the selection grid is able to maintain cod catches well below the 1.5% threshold. The grid has also proved highly effective in reducing the discards (and landings) of other species on observed trips. Total catch of all species was reduced by 48% while landings of *Nephrops* was only reduced by 14% resulting in a much cleaner *Nephrops* fishery ~ 70% of catch (Figure 5.6). The diversity of species caught is also greatly reduced using the grids having both ecosystem and practical benefits (i.e. reduced sorting time).

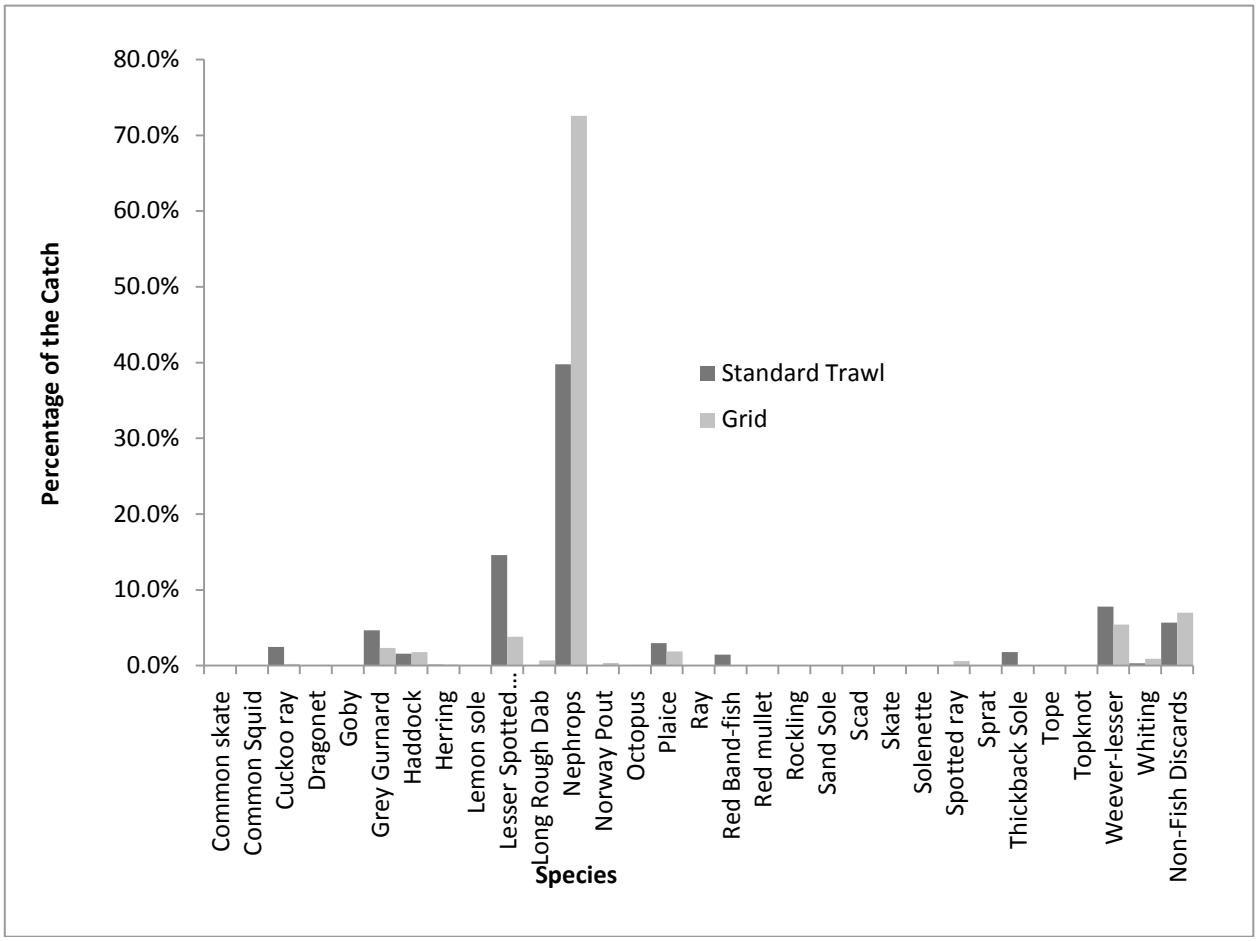


Figure 5.6 Comparison of catch composition in VIIa *Nephrops* fishery between standard trawls and those fitted with a selection grid.

The percentage reduction of catch of cod and whiting was 79% and 72% respectively using the grid which is hugely beneficial given their exploitation status (Figure 5.7).

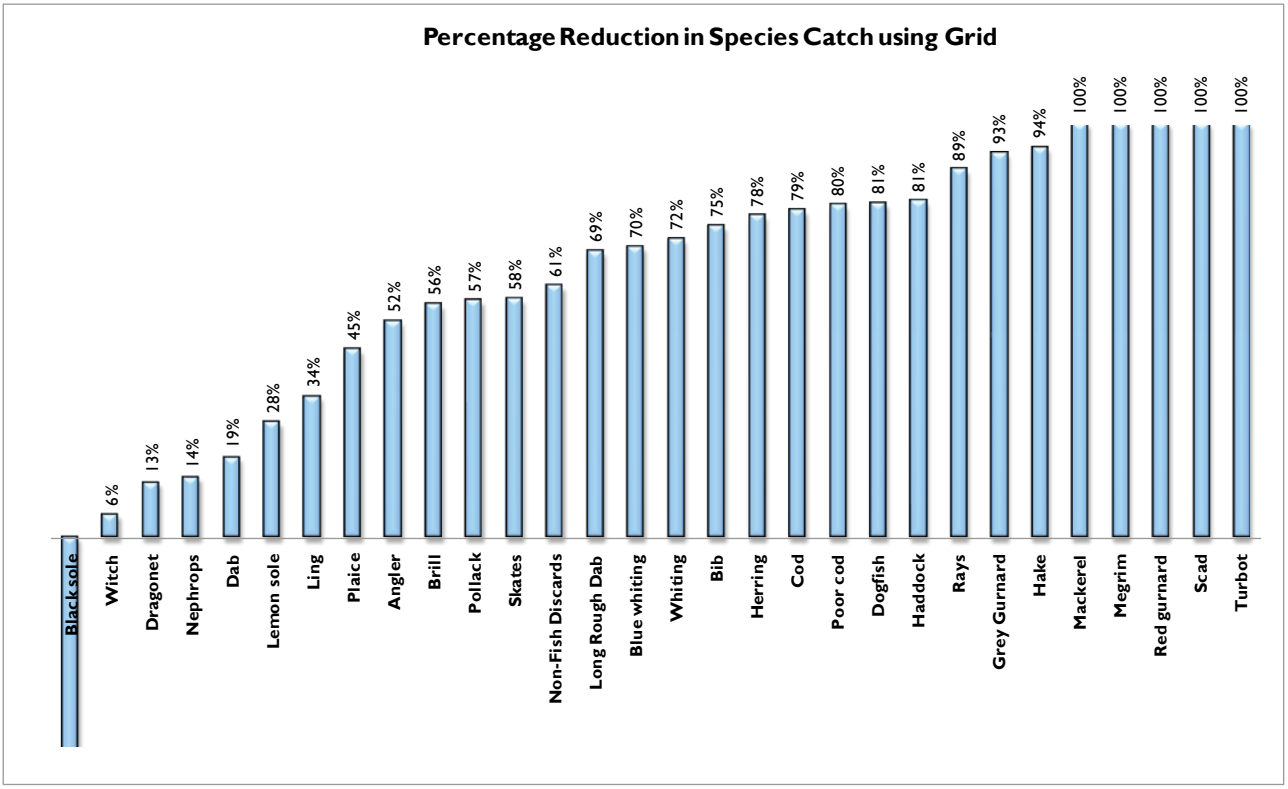


Figure 5.7 Percentage reduction in by-catch species.

Clearly, the use of the grid in the *Nephrops* fishery has benefits in terms of reducing dicsards. From an industry perspective it does however pose questions regardings the loss of commercialy valuable fish by-catch.

The use of the grid does allow for vessels to be exempted from the effort regime but this needs to be considered against the loss of commercial fish by-catch. Ultimately this is a buisness decision that individual vessel operators need to make, but the approach within the managament plan does incentivise the use of grids for the purposes of reducing cod mortality. Possibly this type of incentive could be applied to reducing discards, where individual operators that opt to use more selective gears are provided with stonger incentives and that these rewards are based on pre-defined critria.

6 FINAL COMMENTS

(1) Discarding profiles between countries can vary considerably and in order to determine where the main sources of discards are, it is necessary that an international picture of discarding levels is produced to identify where mitigation measures are required. [25]. If the EU is to effectively address discard problem, then as a prerequisite, an EU wide discard atlas is required. This could then be used to highlight discard problems and identify the appropriate mitigation approach based on the specific discard causes and drivers.

(2) Discarding of the main commercially exploited species, particularly haddock, whiting, hake, megrim and plaice are resulting in significant under-utilisation of the quotas for these species and reducing discards would result in improved yields and also help in achieving MSY targets required under the Common Fisheries Policy and various international agreements (e.g. Johannesburg Declaration).

(3) The métier based analysis presented shows that discard rate and absolute discard levels vary considerably across métiers and species. The smaller mesh fisheries targeting *Nephrops* typically have the highest discard rates, but do not necessarily make the highest contributions to the overall discard levels (with the exception of the Irish Sea fishery). The data presented identifies the métiers making the largest contributions to discard levels and therefore makes it possible to target specific measures to achieve the greatest reductions in fishing mortality associated with discarding.

(4) While the Irish sampling programme has broad coverage, like all other EU at sea programmes, the sampling coverage relative to the total fleet effort is small, typically less *than* 1%. The low sampling levels and the natural variation in discarding levels between trips even with the same vessel and gear makes the data very 'variable'. Given the changes that have occurred in Irish fisheries over the period that this Atlas covers (e.g. decommissioning programmes, effort restrictions, technical changes to mesh regulations etc) one would hope to see these changes being reflected in the discard levels over time. However, it is not possible to see any definitive trends due to the inherent high variability in the data, changes in recruitment and the low relative sample size. STECF [25] have noted that in order to monitor the effect of introducing mitigation tools to reduce discards that it would be necessary to increase at sea sampling considerably if the data collected was to be used as a monitoring tool to evaluate changes in discarding over time.

(5) Discarding is a consequence of market and the regulatory framework in which vessel operators' work within. Understanding why discarding occurs is an important factor in determining the appropriate tools to mitigate the issue. The review of technical measures shows that while the technology to reduce discards exists, its utilization in European fisheries appears to be lacking. There are two likely explanations. Firstly, it may be technically difficult to separate the target from non-target species without incurring losses of target species that render the fishery economically unviable; or secondly, where the technology has been tried and tested, there is a lack of incentive for fishers to use it. Short term losses or technical implementation difficulties such as onboard handling issues, safety concerns or simply conservative attitudes can present a significant barrier to utilization and these also need to be considered. In addition it is clear that in many management zones, there appears to be little or no incentive at an individual vessel level to reduce discards.

(6) Where fisheries are regulated based on landings rather than catches, the most cost effective option available is to discard unwanted catches rather than use technical solutions to avoid initial capture. This lack of cost associated with discarding means that there is little benefit at the individual vessel level to undertake remedial action and apply mitigation methods. While there may be desire to improve the exploitation pattern of fishing gear, the fact is that reducing discards will often lead to reductions in fishing efficiency and/or require increased capital investment. As a consequence, unilateral action to reduce discarding will tend to result in a competitive disadvantage relative to others engaged in the fishery providing little of no incentive. Unless costs associated with discarding are internalized at an individual level, where failure to reduce discards results in a competitive

disadvantage, those who try to act in a responsible manner under the current framework will continue to be disadvantaged.

(7) In a review of the management framework of three demersal trawl fisheries in the North Atlantic and Pacific, it was noted that in fisheries where there is a penalty associated with the capture of unwanted species or juveniles, these fisheries tend to have lower discard levels [26]. There are a number of penalties or costs that can apply, such as limiting of access to fishing areas unless catches are maintained below pre-defined limits or where premature closures of fisheries are triggered by the uptake of a bycatch quota. These have all provided strong incentives to fishers to improve their selectivity in the cases examined. Maximizing fishing opportunities but within realistic and pre-defined boundaries is likely to offer the best incentive for fishers to reduce unwanted discards and bycatches in trawl fisheries. In the context of Irish fisheries, provisions of the long term management plan for cod has offered strong incentives to adopt fishing practices that reduce cod catches by limiting effort restrictions through cod avoidance measures or allowing vessels to be excluded from effort restrictions by demonstrating that cod catches are below pre-defined limits. This results based approach may also offer potential to encourage fishermen to adopt more selective gears in the European context.

(8) Discarding of commercially exploited species tends to be problematic when stocks are over fished. Overexploited stocks tend to have few older fish and fisheries therefore rely on younger, smaller fish. As selectivity is not knife edged, this can often result in large catches of fish below minimum landing size. Increasing the amount of older fish in the stock through reductions in fishing mortality will significantly help in mitigating the impacts of discarding at a stock level. Trawl modifications are likely to continue offering attractive means to reduce discards – ultimately it is the fishing gear that catches the fish – the challenge is to successfully apply these into commercial fisheries. Policies that discourage discarding and offer incentives to those that reduce unwanted catches are central to the successful reduction of discards.

(9) Societal demands to reduce discarding and other impacts associated with trawling are growing. Consequently, pressure is increasing on policy makers, fishermen and scientists to 'do something' about the 'discard problem'. However, in order to identify what options are most suited and their likely impact, fisheries should first be evaluated (audited) to identify the specific discard problems and to reference these against the available mitigation tools [2].

(10) This Atlas represents a first attempt at auditing Irish fisheries and proposes some options to mitigate discards.

APPENDIX 1 DETAILED MÉTIER DESCRIPTION

GNS VIIbcgjk Dem – Trips carried out within VIIb, VIIc, VIIg, VIIj, or VIIk using gillnets to target demersal species, such as saithe, ling, and pollack; cod; rays; hake and forkbeard.

SSC VIIa Dem – Trips carried out within VIIa using Scottish seines of mesh size 70mm or more to target demersal species, primarily haddock and whiting.

SSC VIIgj Dem – Trips carried out within VIIg or VIIj using Scottish seines of mesh size 70mm or more to target demersal species, primarily haddock and whiting.

TBB VIIa Dem – Trips carried out within VIIa using beam trawls with mesh sizes between 80mm and 89mm to target demersal species, like ray and flatfish species, or megrim, monkfish, witch and lemon sole.

TBB VIIefgh Dem – Trips carried out within the VIIe-h area using beam trawls with mesh sizes between 80mm and 89mm to target demersal species, like ray and flatfish species, and megrim, monkfish, witch and lemon sole.

OTB VIa Dem – Bottom otter trawl trips, regardless of codend mesh size, fishing within VIa targeting demersal species. Target species groups include whitefish and slope species.

OTB VIa Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 119mm, fishing within VIa targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 40% of total trip landings.

OTB VIa VIIbcjk Meg & Monk – Bottom otter trawl trips, regardless of codend mesh size, fishing within VIa, VIIb, VIIc, VIIj, or VIIk targeting megrim and/or monkfish. These trips contain 30% or more megrim or monkfish of total trip landings.

OTB VIIa Dem – Bottom otter trawl trips, regardless of codend mesh size, fishing within VIIa targeting demersal species. Target species groups include whitefish, and ray and flatfish species.

OTB VIIa Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 89mm, fishing within VIIa targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 45% of total trip landings.

OTB VIIb Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 119mm, fishing within VIIb targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 45% of total trip landings.

OTB VIIbc Dem – Bottom otter trawl trips, regardless of codend mesh size, fishing within VIIb or VIIc targeting demersal species. Target species groups include ray and flatfish species, whitefish, and slope species.

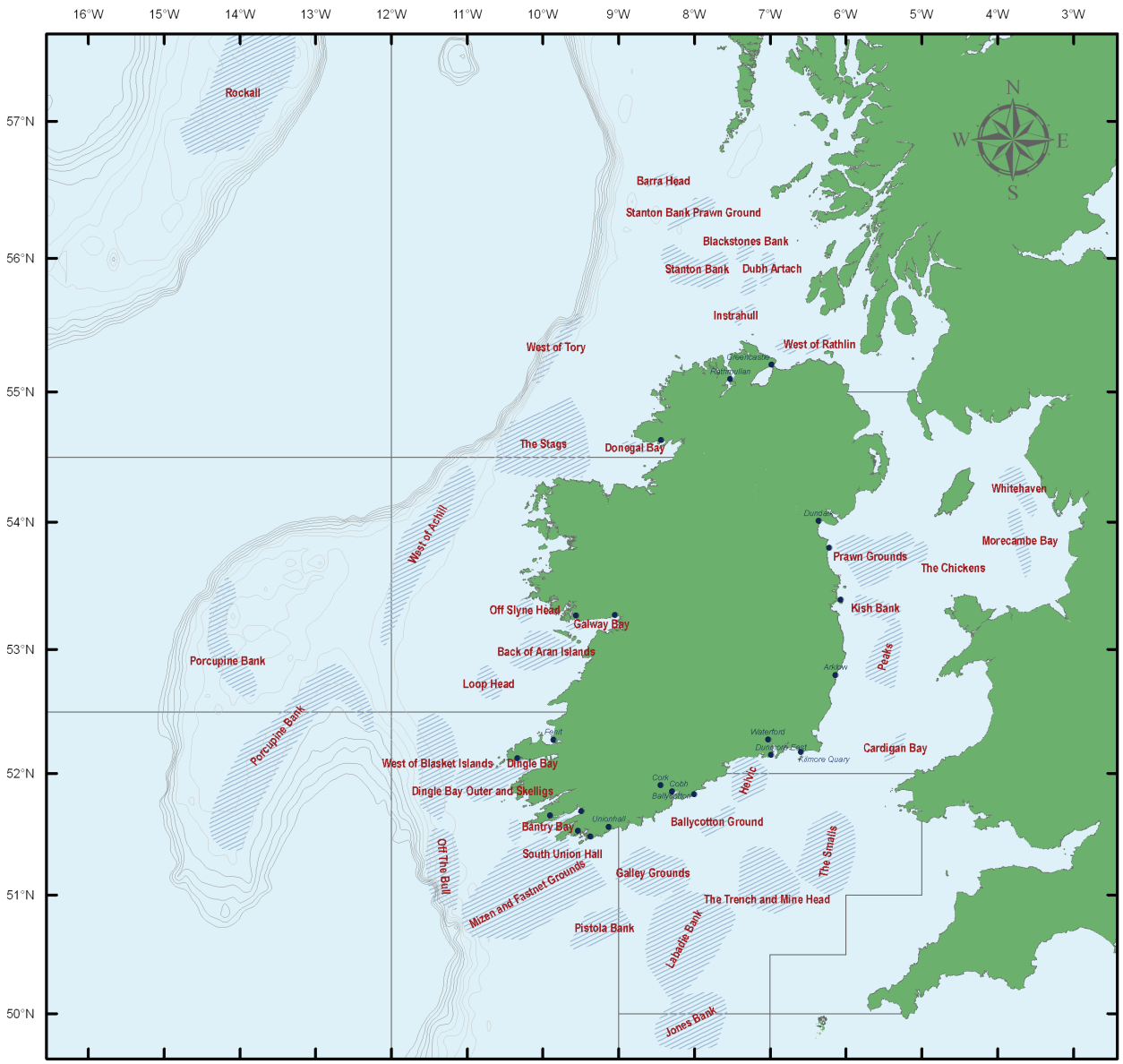
OTB VIIck Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 119mm, fishing within VIIc or VIIk targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 50% of total trip landings.

OTB VIIfgjk Dem – Bottom otter trawl trips, regardless of codend mesh size, fishing within VIIf, VIIg, VIIj and VIIk targeting demersal species. Target species groups include whitefish, and ray and flatfish species.

OTB VIIgfh Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 119mm, fishing within the VIIf-h area targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 40% of total trip landings.

OTB VIIj Neph – Bottom otter trawl trips using a codend mesh size of between 70 and 119mm, fishing within VIIj targeting *Nephrops*. The *Nephrops* component of landings constitutes at least 35% of total trip landings.

APPENDIX II MAP OF IRISH FISHING GROUNDS



APPENDIX III DEFINITION OF FISHERIES TECHNICAL TERMS AND ACRONYMS

By-catch The part of the catch that is captured incidentally to the target species which may have some economic value.

Catch The total number (or weight) of fish caught by fishing operations. Catch = Landings + Discards.

Cod Long Term Plan (CLTP) Is a fisheries management regulation aimed at rebuilding cod stocks but also introducing effort controls for certain gear types linked to cod mortality (EC Reg 1342/2008)

Commercial Fish Species Here commercial species are defined as those that have an established commercial value in demersal fisheries e.g. *nephrops*, cod, haddock, whiting, plaice, megrim, black sole.

CFP / Common Fisheries Policy The instrument of fisheries management within the European community **(see http://ec.europa.eu/fisheries/cfp_en.htm)**

CPUE /Catch Per Unit of Effort The catch of fish, in numbers or in weight, taken by a defined unit of fishing effort. Also called catch per effort, fishing success, or availability.

DPUE /Catch Per Unit of Effort The discard of the overall catch, in numbers or in weight, taken by a defined unit of fishing effort.

Demersal Fish, such as cod, whiting, haddock, sole, plaice, megrim, hake, monkfish normally swim in mid-water at or close to the sea floor.

Discard Are the portion of a catch of fish which is not retained on board during commercial fishing operations and is returned, often dead or dying, to the sea.

Discard Rate The percentage or proportion of the catch discarded (in weight or numbers).

Discard level The total amount of the catch discarded (in weight or numbers).

Effective fishing effort Fishing effort or intensity standardised in some way e.g. hours fished in an area with a particular gear type corrected for by vessel power.

Fisheries A group of vessel voyages targeting the same species, using similar gear, during the same period of the year and within the same area e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea.

Fishing Effort The fishing effort is a measure of the amount of fishing. Frequently some surrogate is used relating to a given combination of inputs into the fishing activity, such as the number of hours or days spent fishing, numbers of hooks used (in long- line fishing), kilometres of nets used, etc. The European Union defines fishing effort as fleet capacity (tonnage and engine power) x days at sea (time; t); the formulas are GT x t and kW x t.

Fishing Mortality Is the removal and death of fish from the stock due to fishing activities using any fishing gear. Where discards are accurately known total fishing mortality can be partitioned into that caused by landings and discards.

High Grading Is the practice of discarding fish above the minimum landing size for economic reasons i.e. not marketable or to maximise the monetary return from limited quota.

ICES International Council for the Exploration of the Seas –Ireland shares the Total Allowable Catches TACs for many stocks we exploit with our European Union partners. Because of this international dimension many stocks need to be assessed in an international fora such as ICES. **(see: http://www.ices.dk/)**

Landings Fish or shellfish that are brought ashore.

LPUE /Catch Per Unit of Effort The landed component of the overall catch, in numbers or in weight, taken by a defined unit of fishing effort.

Marine Institute The Marine Institute is Ireland's national agency with the following general functions : "to undertake, to co-ordinate, to promote and to assist in marine research and development and to provide such services related to marine research and development, that in the opinion of the Institute will promote economic development and create employment and protect the environment." Marine Institute Act, 1991 – **(see: http://www.marine.ie/)**

Métier A group of vessels engaged in a fishery e.g. twin-rig trawlers targeting *Nephrops* using an 80mm mesh in the Irish Sea.

MSY / Maximum Sustainable Yield (MSY) The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. (For species with fluctuating recruitment, the maximum might be obtained by taking fewer fish in some years than in others.) Also called maximum equilibrium catch, maximum sustained yield, sustainable catch.

Non-fish Discards Any discarded component of the catch that is not fish, this can include invertebrate species such as crab, anemones and small prawns but also other marine species such as sea-weed. Small Rocks and mud may also be included.

Non Commercial Species Here we define non-commercial species where >95% of the catch is discarded by demersal gears. It should be noted that several of the species are targeted in pelagic fisheries e.g. boarfish, argentine, blue whiting, but in general these are not landed by demersal vessels. For some of the species, a small amount of landings are reported, but this is typically for pot bait.

Pelagic Fish that spend most of their life swimming in the water column, as opposed to resting on the bottom, are known as pelagic species (e.g. Mackerel, Horse mackerel, Herring, Sprat and Sardines).

STECF The Scientific Technical and Economic Committee on Fisheries. Established by the European Commission and comprises fisheries scientists and economists from the member states. The role of STECF is to advise the European Commission on scientific, technical and economic issues related to the management of fisheries resources that are exploited worldwide by members of the European Union. **(see http://fishnet.jrc.it/web/stecf)**

Stock A "stock" is a population of a species living in a defined geographical area with similar biological parameters (e.g. growth, size at maturity, fecundity etc.) and a shared mortality rate. A thorough understanding of the fisheries biology of any species is needed to define these biological parameters.

Target Species A list of species targeted in a métier, for example otter trawls (OTB) may targets demersal species such as haddock and whiting. Gillnets (GNS) may target demersal species such as saithe, ling, and pollack; cod; rays; hake and forkbeard. Beam Trawls (TBB) may target species, like ray and flatfish species, or megrim, monkfish, witch and lemon sole. See Appendix 1 for detailed métier description and their associated target species.

TAC / Total Allowable Catch is the total regulated catch from a stock in a given time period, usually a year.

TCM / Technical Conservation Measures These measures take the form of closed areas, increased mesh sizes and gear modifications (such as separator panels) and are aimed at protecting specific stocks, or age-classes within that stock, from overfishing.

Unaccounted Fishing Mortality Any deaths that are not quantified, for example fish lost during retrieval of the gear and not taken on board, illegal landings, fish deaths due to contact with fishing gear but not caught or fish caught in lost or abandoned fishing gear.

VMS Vessel Monitoring Systems are used to monitor the activities of all EU fishing vessels over 15m in length by transmitting their position via satellite at least every 2 hours

Whitefish Term used to describe demersal species such as cod, plaice, ray etc., as opposed to pelagic or salmonid species.

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